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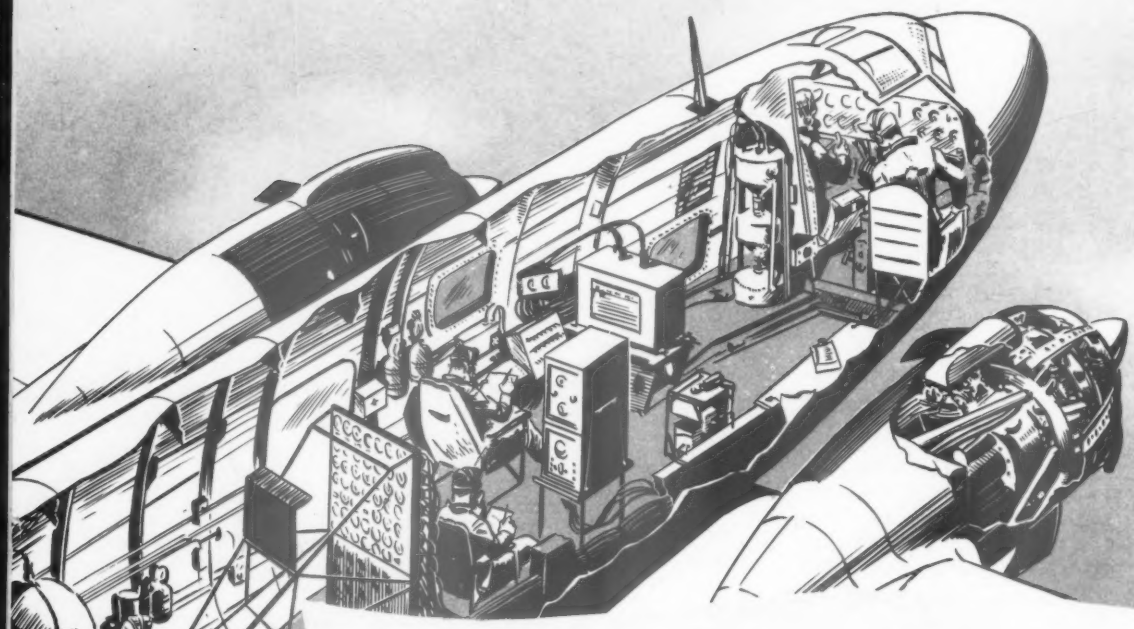

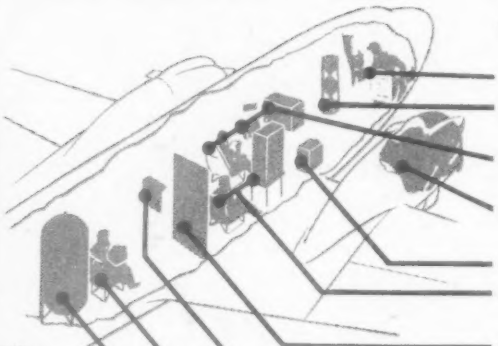

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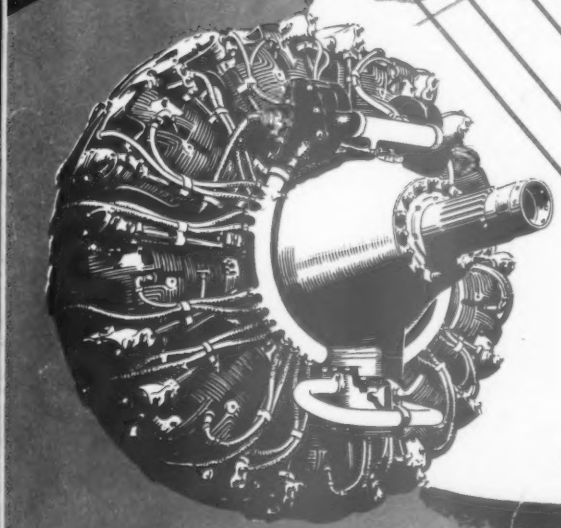

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DECEMBER, 1945

VOLUME 37 • NUMBER 6

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EMERGENCY ISSUE

Chicago: "Publishers of nearly 200 business papers, of scores of general magazines and of hundreds of house organs, catalogs, etc., have been thrown into turmoil here by a strike that has shut down Chicago's printing industry"—Advertising Age.

This publication was one of those affected. We know it does not meet our usual standards of presentation and appearance, but we believe you would rother have such an issue than none at all. We hope, therefore, that you will bear with us until next month, when we can again resume the publication of a normal issue.

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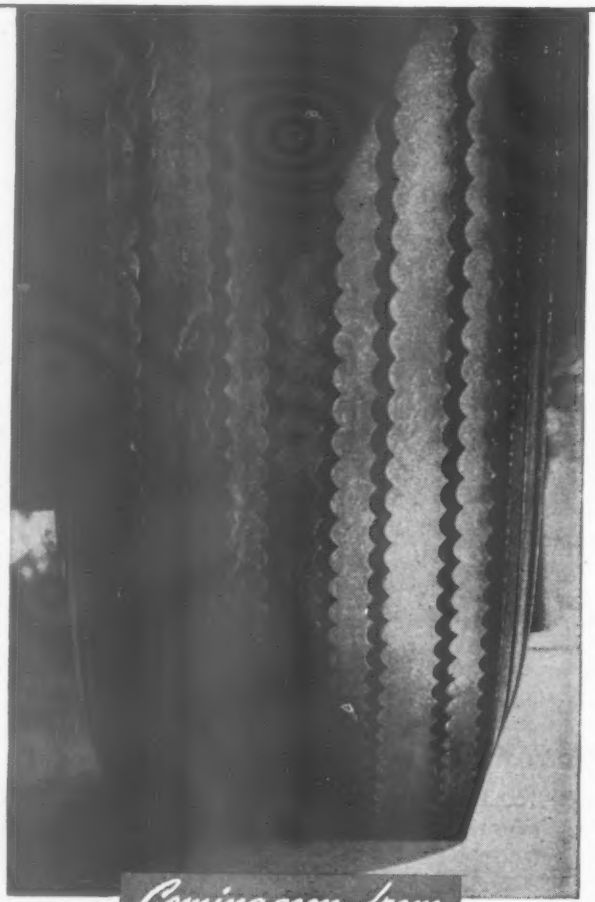

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This test in 1923 helped prove the battleship vulnerable. Bomb exploding on U.S.S. Virginia is one of 1,100-pounders in the inset.

...The Same Mistake AGAIN?

By ELBERT D. THOMAS
United States Senator from Utah

Once again our air forces face determined opposition from surface-bound diehards

THE few weeks left in this year—packed with historic drama though 1945 has been—may well be the most crucial in our national history, if not in the history of the world.

In that brief period the ground work policy concerning the future role of the airplane in our civilization must be determined.

If decision is delayed we are threatened with a chaotic present and a potentially disastrous future. And what we decide to do with aviation inevitably will guide our future economic, social, political and diplomatic decisions in all aspects of our national and international life.

Five major questions must be faced immediately and policy laid down toward their solution:

1. What are we going to do toward maintaining our air forces?

2. Are the AAF and the Navy air arm going to be separated from our other defense groups, will they be made the controlling factor in our fighting structure, or will they be relegated to their pre-war

status of military stepchildren?

3. What measures are going to be taken to control the airplane in its relationship to the atomic bomb?

4. What international regulations are going to be laid down concerning the freedom of the air in which planes, both military and commercial, move?

5. Domestically, what measures are going to be taken toward full-throttle aircraft production and the employment that such production implies?

If we answer these questions correctly, we will have the answers to scores of other parallel questions concerning machines, radar, radio and other developments in the scientific new world upon whose threshold we now stand. Answer them quickly and accurately and we can, for generations to come, enjoy the fruits of that world. Postpone the answers—delay bringing our political, economic, social, and diplomatic thinking abreast of the breath-taking advances of science—and the result may well be anarchy.

It is one of the ironies of modern civilization, and an index to how far our social thinking is behind the scientists, that it is necessary to cite the above alternatives at this late hour. Despite the prophecies of Peary, Douhet, Mitchell, Seversky, and Ziff, to say nothing of the history of the past 10 years, people are still debating the value of air power. It still is necessary, before facing our present dilemma, to review the record, to repeat the predictions that such far-seeing men as Admiral Peary made at the beginning of the century.

Peary's predictions are most clear in my mind because I heard him make them in person, and because they impressed me as strongly as did the unbelievable opposition which arose after he uttered them. His words typify what advocates of aviation are saying today, and his opponents' words typify that benighted opposition which, even now, threatens to block our progress.

My meeting with the Admiral occurred several years before the Wright brothers flew at Kitty Hawk. I was a student at the University of Utah and he was on a tour of the country lecturing on the Arctic; but in a special forum for students after his regular address he surprised us by speaking, not of the far north, but of aviation.

He spoke dramatically of the coming air age, said that future generations would learn to fly with as much ease as we had learned to swim, and predicted an unlimited future for heavier-than-air craft both in war and peace.

He never changed his views. By 1916, on the eve of our entry into World War I, he was saying, "He who commands the air, commands all."

"Our Army and Navy," he declared, "are virtually blind. We have less than 200 trained aviators in the services. These 200 will be busy training other men to fly. We have not a single airplane equipped with a gun."

As early as 1915 he insisted that the best defense of this country would be an aerial coast patrol, and anticipated the use of bombers.

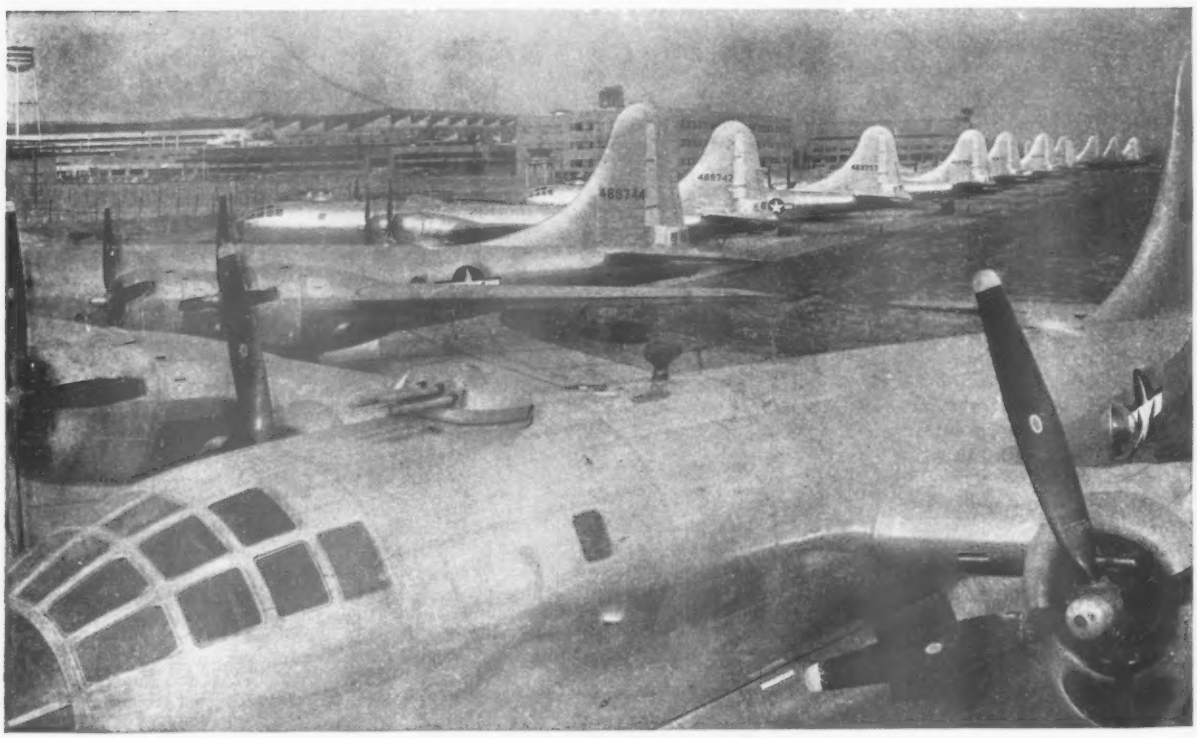
"In no way can we as a nation stand so effectively for forcefulness, for strength and for world influence as by command of the air. Great and important as is a sufficient Navy for our safety, I speak advisedly when I say that our air service of the near future will be more vital to our safety than our Navy and our Army combined."

He went further, predicting the role of the airplane in a peacetime economy:

"The work of air preparedness," he said, "is not just for the present (World War I) emergency with Germany. This is only a present incident which should spur us to more immediate readiness. This work of air preparedness is for preparedness on our part for that great realignment of powerful, conflicting and impoverished interests which is surely to come at the end of this war, and which is a far greater contingency for us than a possible war with Germany under present conditions. This matter is for preparedness even beyond that—preparedness also for that commercial air power which is coming in the future and in which we should lead."

He went on to visualize a network of airmail lines around the world, advocated Federal control of pilot licensing, a Secretary for Aeronautics in the Cabinet, civil aeronautics committees in Congress, and foresaw the need of air laws to fit a three-dimensional world.

He was hailed as a visionary and a crackpot for his pains. "Apparently man was built to stand upon the ground," declared the editor of the North American Review a few months after the Admiral had spoken to us in Utah. "Strife against the force of gravity, therefore, may be re-



U. S. air forces, both Army and Navy, must be maintained at the highest possible peak, regardless of cost. First-line aircraft, like these Superforts, must be available immediately in large numbers in case of a national crisis. Research must go ahead on a large scale.

Big peacetime hope of American manufacturers now is a large, healthy market for civil aircraft, both personal and commercial. Airliners like these Lockheed Constellations are in large-scale production for the American-flag airlines that soon will cover the entire world.

garded as contrary to the intention of the Creating Power." "Winged angels or demons" would have to be used as policemen, he suggested, if the wild dreams of the air enthusiasts were realized. Even scientific men at that time, while admitting that men could fly in heavier-than-air machines said that they would probably never do it because after they once got in the air they could not with safety set down on the ground again. The problem to them was not flying but landing.

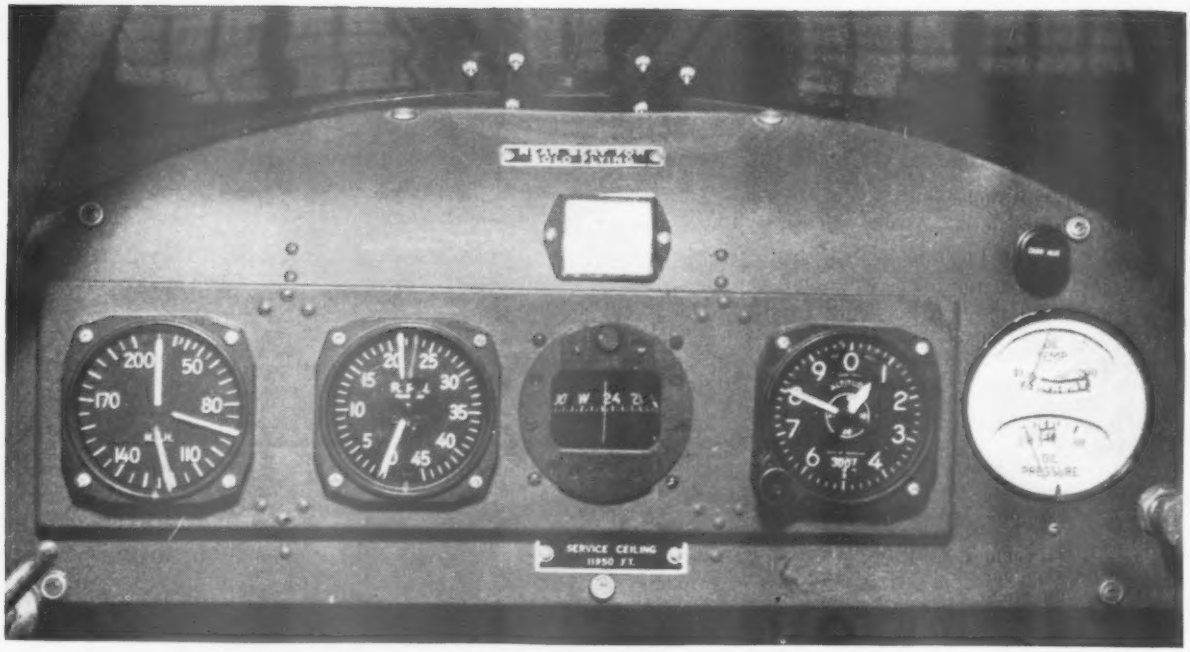
Succeeding, although against great odds, in establishing his wartime flying coast patrol, Admiral Peary did not succeed in avoiding ridicule. An article in the Bellman magazine as late as 1917 decried his campaign on the grounds that it "merely tends to create alarm and spread the spirit of panic."

Nor is his career as an advocate of aviation reviewed here in some detail simply for amusement. Down through the years, and even to this day, aviation and its supporters have been subjected to similar opposition. General Billy Mitchell is a classic example. Perhaps more classic still is the exclamation of Adm. William B. Shoemaker on reading the report on Mitchell's bombing experiments on warships off Cape Hatteras in 1923.

"It's true, every bit of it," groaned the admiral, "but, my God, we can't let this get out or it would ruin the Navy."

"If a storm doesn't come up and blow these damn planes away," said another admiral attending the bombing demonstrations, "the Navy will go out of busi-

(*Continued on page* 100)



Instruments in Army L-4 "grasshopper" are, left to right, air-speed indicator, tachometer, magnetic compass, sensitive altimeter, oil temperature and pressure gauge. Civilian Cubs have similar group, but are less expensive than military type.

INSTRUMENTS
FOR THE PRIVATE FLYER

By Col. T. B. HOLLIDAY
Asst. Chief, Equipment Laboratory, ATSC, Wright Field, O.

Simple aircraft instruments, standardized panels will make flying safer, easier and more efficient.

THE ranks of private flyers should be increased in the very near future by returning pilots, air crewmen and ground crews. These new men will have had a great deal of experience with the best aircraft and aircraft equipment that American industry can produce. This will contrast greatly with the aircraft and equipment now available in the lower-priced private aircraft—which is the only type ex-servicemen can afford to fly.

This article proposes to analyze the instrument requirements for low cost private planes with the view of establishing a median ground between the extremely expensive and efficient instruments used by the military services and the low cost instruments which must be used by private flyers.

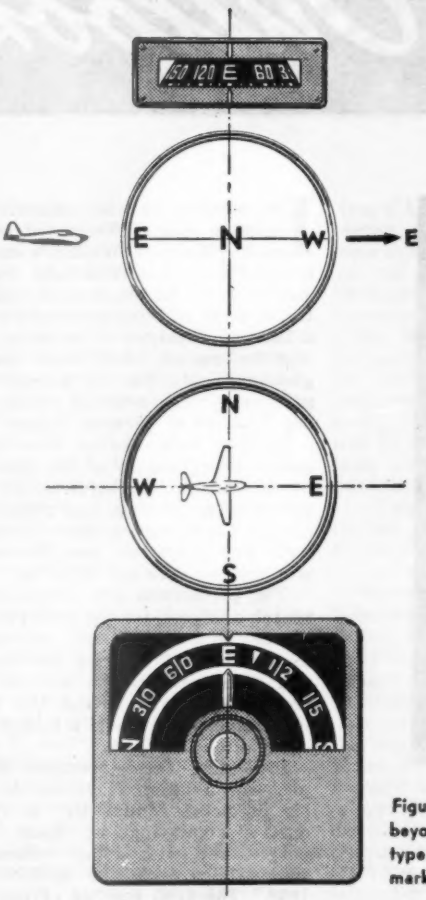
The functions of instruments can be divided into two or three classes. First, instruments are required to observe and indicate the operation of the engine, or engines. Second, a quite different class of instruments is required to aid cross-country navigation. A third and minor group of instruments might include indicating devices which show the position of aircraft parts, such as landing gear and flaps.

An instrument panel used in some private airplanes is shown in the photograph. This includes instruments for operation of engines, such as tachometers, oil pressure and oil temperature. The navigational instruments will include only the compass, air speed indicator and altimeter. In most cases radio facilities will not be included, and since most private aircraft are quite simple in operation the landing gear and flap position indicators will not be included or will be quite simple mechanical couplings to the mechanism itself.

In determining the best arrangement of instruments for the private airplane, some of the objectives in these instruments should be reviewed. In the first place the instruments should be easy to read. These should be designed into the airplane so that the instruments are readily visible and important indications on the dial should be obvious. If it is possible, they should be arranged and designed so that a similar indication is achieved in all airplanes. Too often it is necessary for a pilot to ask the cruising R.P.M. and best climbing speed in a conventional airplane. It should be possible to arrange the instruments so that such critical operating points are obvious. In many types of instruments the values are not important. But some point or zone in the range of indication of this instrument marks a dangerous operating condition. Such zones should be prominently marked.

The development of aircraft instruments

(*Continued on page 92*)



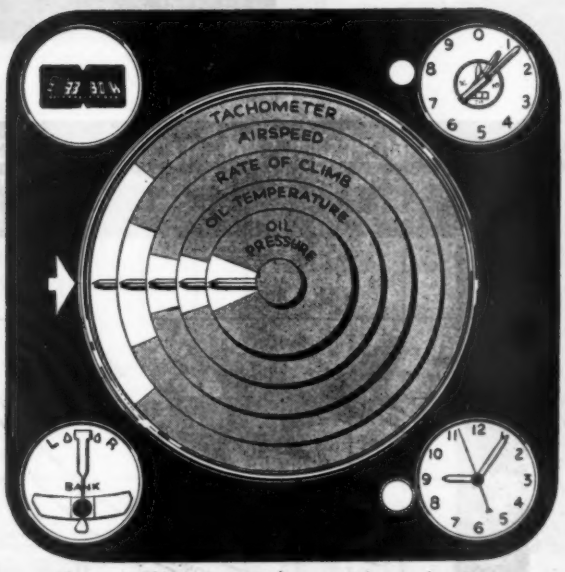


Figure 1. This instrument has coaxial-geared pointers which, when aligned, indicate proper throttle setting, plane altitude for cruising performance. White areas suggest maximum and minimum readings for safe flight.

Figure 2. A conventional compass (top) places observer beyond horizon instead of over earth's center. Needle type (bottom) shows horizon as pilot sees it. Course mark on card (white vee) should be aligned with needle.

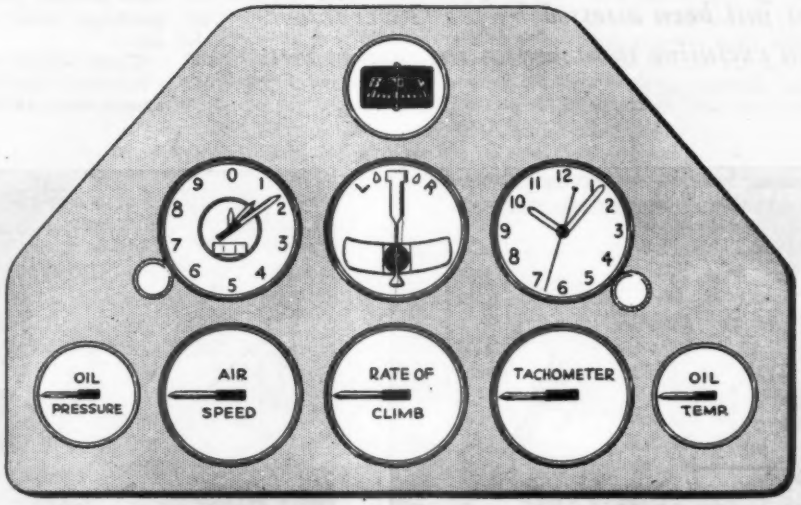
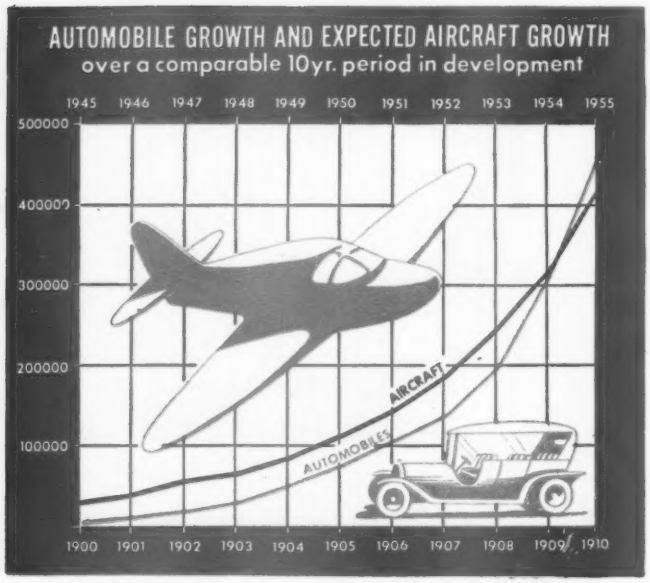


Figure 3. This panel, proposing use of separate instruments, utilizes the horizontal needle principle shown in Figure 1, but would be more economical and easier to service. With plane in level flight, all needles should align with rate of climb.

The Outlook



By FRED HAMLIN

Washington Editor of FLYING

Civil aviation's growth potential in the United States has just been assessed by the Government. This is an exclusive summary of the new report.

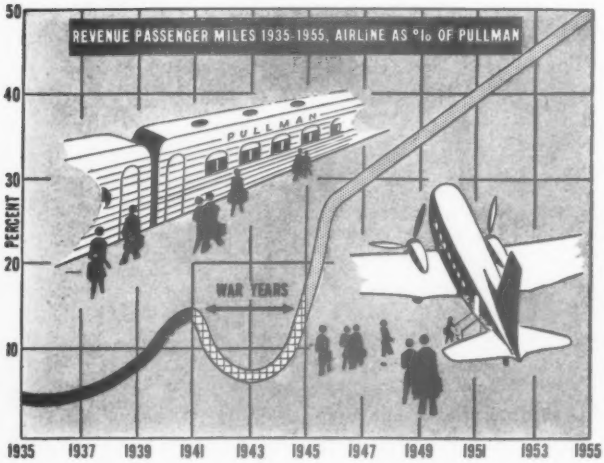
IN what might be considered the opening gun of Secretary of Commerce Henry A. Wallace's campaign for 60,000,000 post-war jobs, the Civil Aeronautics Administration and the Department of Commerce have released a 147-page analysis of aviation, a salient feature of which says that "the greatest field for the immediate expansion of civil aviation exists in the development of personal flying."

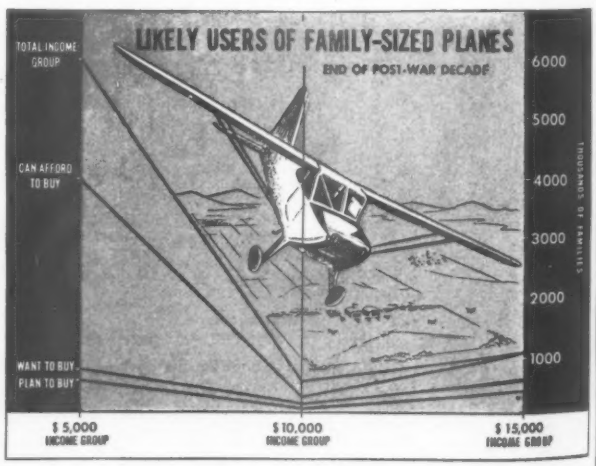
Replete with charts, the analysis covers every aspect of the industry—manufacturing, employment, air transport, pilots, training, and personal aircraft — and each section is climaxed with predictions on how far aviation will have progressed by 1955.

The predictions are based upon research analyses, for the most part made by members of the CAA, and upon the assumptions that during the first post-war decade the nation will not suffer from unemployment and the Federal Government will spend a billion dollars on aviation activities.

Projecting these premises into the post-war aviation economy, the analysis predicts "confidently" a 1955 industry employing at least 630,000 people, and with dollar volume more than tripled from the $800,000,000 in 1939." The 1955 number of passengers carried by airlines will be up to 20,000,000 in domestic operation and 2,000,000 abroad, total air carrier revenue will have reached $422,450,000, the average passenger fare per mile will be 2.5 cents.

There will be more than 400,000 civil airplanes in use following a 30 per cent annual increase for the decade, and pri-





for Aviation

vate plane gasoline consumption will bulk to 635,400,000 gallons as compared with only 510,000,000 gallons consumed by scheduled domestic airlines. This is also in marked contrast to the 1939 consumption totals of 16,394,335 for private operators and 46,554,856 for scheduled transports.

Concerning personal flying, the CAA compares the lightplane's present situation to that of the automobile in 1903, when there were some 30,000 registered cars. CAA has almost an identical number of planes certificated in 1945. In the 1900-1910 decade, autos increased at the rate of approximately 48 per cent a year, or to 468,500 in 1910.

"Cutting the expected rate of growth to allow for the still-prevalent fear of air as a medium of transportation," the CAA reasons, "it still is possible to foresee confidently a 30 per cent annual increase in aircraft, as they acquire greater utility and more airports are provided. Allowing for reasonable reductions in operating costs of the aircraft which are already on the way, and projecting national income in terms of full employment, in 1955 there will be 2,800,000 families that can afford airplanes. Eliminating from this maximum potential those who will not be interested in owning airplanes (as shown by several privately-conducted surveys of interest in flying, which reach very similar conclusions), it would appear that there will be well over a million families willing and able to buy airplanes."

(Also see "There's a Prediction for It," FLYING, March, 1945—Ed.)

Of the 400,000 in the more conservative CAA estimate, 280,000, it is predicted, will be used for personal business and recreation, 40,000 by businesses, and 80,000 for crop dusting, aerial photography, instruction, and other non-scheduled operations.

On the instruction problem, CAA proposes elementary flight instruction for 40,000 college students, veterans, and others, at a cost of $14,860,000 annually, of which the government shall pay 75 per cent. CAA elementary and high school aviation study should be continued.

Two other proposed Federal expenditures of special interest to lightplane flyers would be for research and for airport construction.

"Research on the human element, technical development to aids to navigation, and basic research looking toward improvement of personal aircraft" is suggested at an estimated cost of $1,000,000 annually.

Proposed for the immediate future are studies of propeller and exhaust noises and methods of reducing them, simplification of aircraft controls, development in the fixed-wing lightplane, the advantages of a helicopter, and development of cheaper engines.

CAA proposes to attempt achieving helicopter performance in conventional lightplanes through various high-lift devices and through use of a full power to slow the airplane, "thus permitting landings in limited space and slow flying under conditions of low visibility." Cheaper engines would be achieved by "study of two-cycle planes, turbines, and other types which may offer promise."

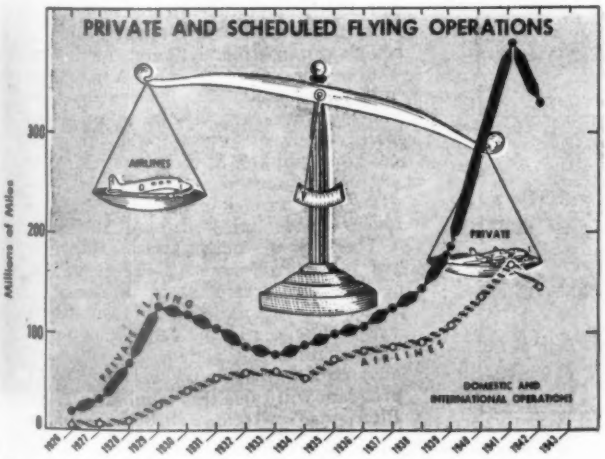
To the question of why industry itself should not do this type of research, CAA answers at some length:

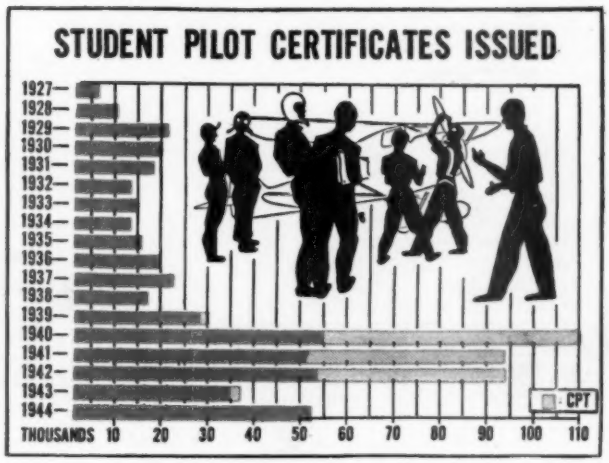
"There are two major reasons why private industry cannot accomplish the necessary development without (Federal) aid. First, there is generally no way for the individual company to prevent other companies from capitalizing on the developments for which it has paid. Second, it is extremely difficult for an individual company to overcome sales resistance to an article which differs materially from those with which the public is familiar.

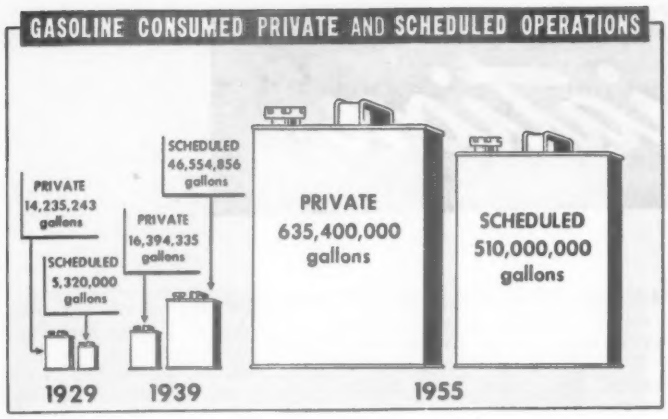
"Business for the most part must judge expenditures of this kind according to whether they will return a profit in the near future. Government can afford to look farther ahead and incur expenditures which, while not profitable within the next five years, will pay for themselves in, say, 10. Moreover, there are some developments which could not be undertaken with profit by a single company, but which would be profitable to the industry as a whole."

In the field of "research on the human element," CAA recommends continued studies on measuring pilot performance and investigating flight instruction techniques, minimum pilot standards, and accident causes. Typical suggested project is a study of minimum standards of pilot vision.

Technical development to aids to navigation will be aimed in the lightplane field toward building a single radio receiver with which "it will be possible for the average pilot to obtain all of the essential airways services." Quoting Thomas B. Bourne, Assistant







Administrator for Federal Airways, the report says that with such a set, "the pilot will be able to receive navigational guidance along the airways, navigational guidance for instrument approaches, and all of the essential two-way radio communications while enroute and while landing and taking off."

Pointing out that the CAA estimate of the growth of private flying may turn out to be "horse-and-buggy," the analysis states that "never before have so many persons been made aware of the transportation possibilities of the airplane." Three million air forces service men, their families, aircraft industry workers and a million students in the public schools who have taken aeronautical courses are among those who have, during the past few years, gained a personal interest in aviation. But to assume that these will all buy airplanes, or even fly, is declared false.

"Two fundamental elements will determine how many among these already interested groups and among the population as a whole want to buy and fly planes," the report states. "First, how many will be able to afford an airplane and, second how many will desire an airplane strongly enough to give it priority among possible post-war purchases?"

On the buying question, CAA had a study made by Victor Perlo of the War Production Board Research Coordination staff, which concluded that with full employment there can be 1,120,000 family planes in 1955. Two and a half times the CAA estimate, this "indicates that programs which seem large when proposed today may well be proved conservative by actual dollar and cents purchases."

The CAA report also brings out that Perlo's estimate checks with the findings of the Crowell-Collier survey, which was confined to urban families. Brighter prospects among farmers are indicated by a third survey cited, made in 1944-45 by Dr. F. L. Whan of the University of Wichita, on the post-war plans of Kansas families. On the basis of Dr. Whan's findings, 1955 will bring a rural market of 362,400 planes, a village market of 412,600, and an urban market of 274,000, totaling 1,049,000.

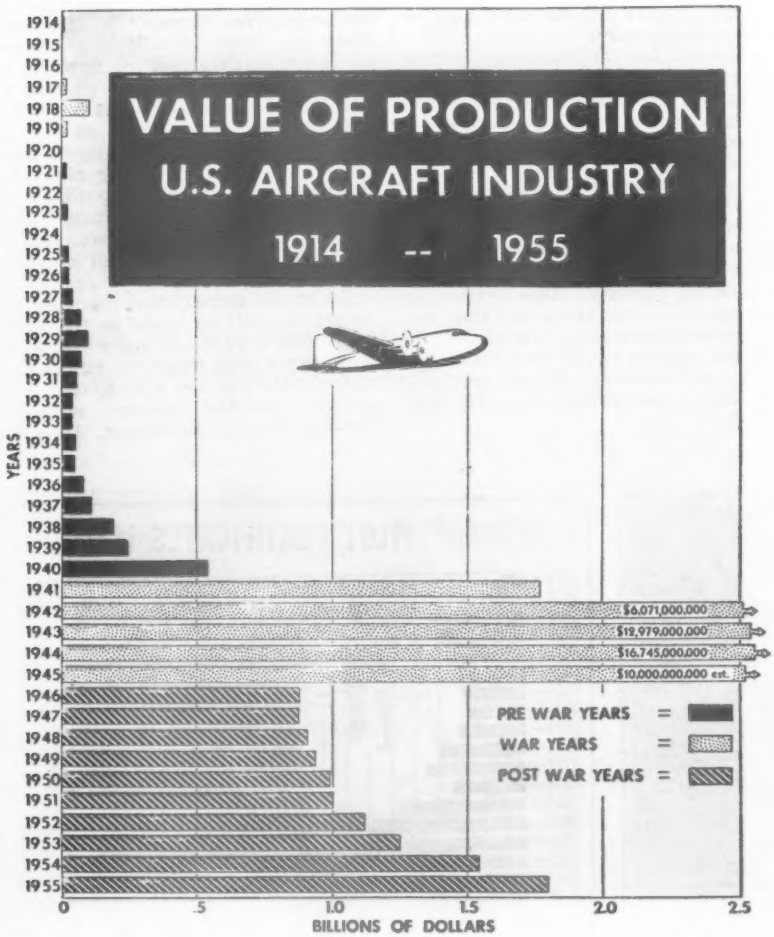
Another optimistic note is the fact that "during seven months of 1944, the CAA War Training Service sold to the general public more than 5,300 aircraft, the greatest number of civil aircraft sold within a comparable period at any time in aviation history. In contrast, the highest number produced for domestic use in any previous seven months was 3,990 in 1941."

"Whether that demand will continue to be washed out in a wave of disillusion," the analysis points out, "hinges upon the success of efforts by Government and industry to correct some of the factors which have limited the sale of small planes in the past and which have caused buyers to give them up after an average ownership of less than four years."

Outstanding among these factors are cost and upkeep, lack of utility, cost of instruction, lack of comfort, low cruising speed, distance from town to port, and weather. CAA proposes to ameliorate the utility and airport difficulties with its second large expenditure of benefit to lightplane flyers. Assuming the necessary funds, the Administration proposes building 3,050 airports in the next decade, 2,900 of them in the personal flying class. The program calls for building of the ports nearer to population centers. Cost of the program will run $1,250,000,000, half in federal funds. [Also see page 29].

The analysis characterizes this program as "grass roots," reflecting the needs and desires of state and local interests. Today, it is pointed out, there are 1,630 cities in the 5,000-25,000 population range, of which only 972 have any sort of landing area. The airport program will raise this number to 1,487. Plans also call for lightplane airports

(*Continued on page 66*)



Senator McMahon

AIRPORTS FOR EVERYBODY

By BRIEN McMAHON

United States Senator from Connecticut

IF legislation already before Congress is enacted, some $3,000,000,000 in Federal airports and funds will be alloted to U. S. civilian aviation during 1946.

If the laws do not go on the books, as much as two-thirds of that sum may be lost to aviation, if not to the Government—which is to say, to the American taxpayer.

The legislation in question is in the form of two bills and a resolution. The first and best-known is the McCarran Airport Bill, introduced by Sen. Patrick A. McCarran of Nevada, which provides for approximately a billion dollars to be spent for new landing areas during the next 10 years. The exact sum had not been set as this went to press, because the matching legislation in the House, introduced by Rep. Clarence Lea of California, is for a variable sum. Passage of both was delayed only to clear up details. An early vote was being planned as this was written.

The third piece of legislation, hardly noted in the rush of fall Congressional activities, involves about $2,000,000,000 worth of surplus airports. It is Senate Bill No. 1398, known as the Surplus Airport Act of 1945. It was introduced by me in September, first as a proposed amendment to the McCarran Bill, later as a separate piece of legislation.

It specifies that title to some $2,000,000,000 worth of ready-built Army, Navy and other Federally-owned landing areas in continental United States —plus Federally-owned hangars and other equipment—be turned over to state or other local political ownership. This includes both counties and municipalities or their political subdivisions,

(*Continued on page 72*)

Naval air base at Bunker Hill, Ind., (above), is one of 44 to be declared surplus by end of year. Navy goal: disposition of 79 major installations, 233 outlying fields by mid-1946; reduction of major Naval air facilities from present 169 to 94.

Handling the SEAPLANE

Seaplane should approach landing dock slowly alongside instead of directly toward it.

By GEORGE B. POST

BEFORE a take-off the seaplane engine should be warmed up at the ramp or float or by taxiing about. For the take-off run, lift up the float rudders, open the throttle wide immediately, and pull the stick all the way back, thus lifting the bow of the floats and getting through the spray period as quickly as possible. With an average plane the floats normally will tend to rise by the bow to a certain height and then commence to flatten out.

As soon as the pilot sees that the bows are not rising any further he should let the stick ride forward to a more or less neutral position. At this juncture, with a peppy plane, the floats will immediately begin to plane and run along a more nearly level position on the step. At this point, in rare cases, the pilots may have to push the stick forward somewhat ahead of neutral in order to help the plane on the step but this is generally unnecessary.

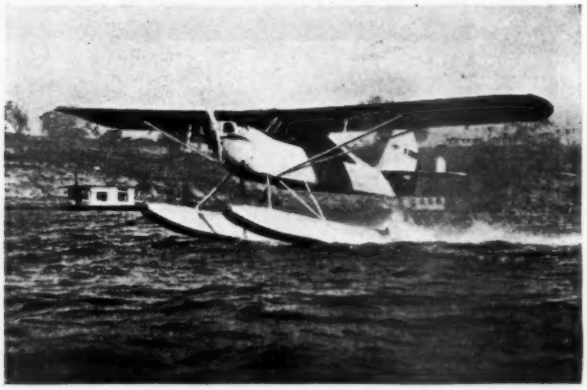
After the plane is on the step, it usually requires a slight back pressure

The author, a recognized authority on seaplanes, is vice president of the Edo Aircraft Corp., College Point, L.I., N. Y., pioneer manufacturers of aircraft floats. He has been a pilot since 1918 and has been with Edo since 1928, also having served as that company's test pilot. He served in the Navy in World War I, and still is a member of the Naval Reserve.

PART TWO

Though they fly like conventional craft in the air, seaplanes need special handling on water.

Seaplane on take-off. The most efficient planing angle is one at which tail of float almost, but not quite, touches water.



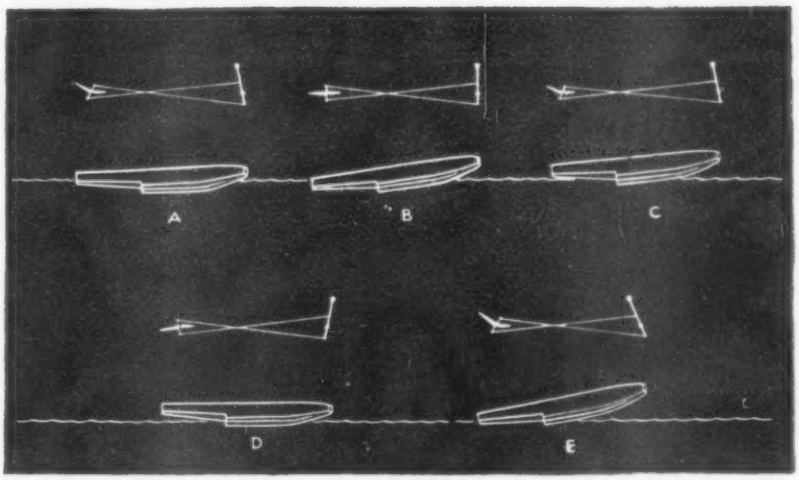
Normal landings may be semi-stall, with the tail and step of the floats touching the water more or less simultaneously.

on the stick to hold the floats in the most efficient planing position, which approximates their attitude when the plane is at rest on the water. This attitude should be maintained as steadily as possible until take-off speed is reached, at which time a slight additional back pressure on the stick will lift the craft clear of the water.

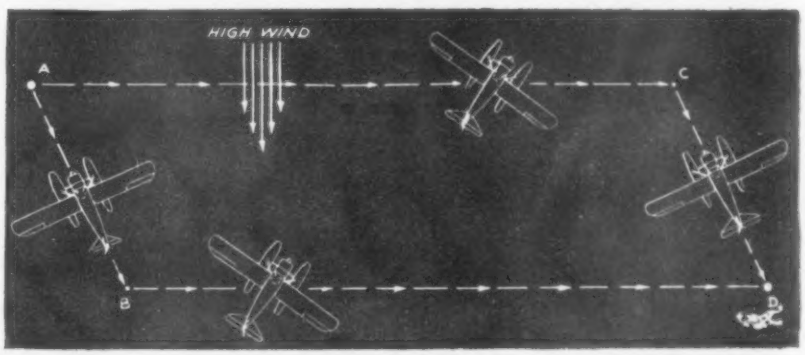
Some good seaplanes have a moderate tendency to rock or porpoise. This action generally occurs at about the time, or immediately after, the plane goes on the step. It is also likely to occur if the ship is taxiing on the step downwind and may occur when falling off the step after a landing. Porpoising of this nature with power on can normally be checked by the controls, but any exaggerated movement of the controls ought to be back rather than forward. In other words, if the bow rises, push forward very slightly; and as it falls, pull back rather hard. Porpoising with power off, as on landing, can best be checked by holding back hard on the controls. Any violent porpoising with power on should always be treated by cutting the throttle and following this practice.

Some craft are difficult to get on the step and a little rocking or porpoising will sometimes help. There is no use attempting it, however, until the bow has definitely come full up to the point where the seaplane is about to go on the step, since any forward stick before this point is reached will do nothing but push the bow back into the water. Rocking is accomplished by moving the controls rhythmically forward and back (with emphasis on the forward), so as more or less gently to "nudge" the plane on the step, but it is important not to let the rocking become too exaggerated. If any uncontrollable rocking develops, it can generally be checked by cutting the throttle and pulling back the stick, forcing the tail of floats into the water.

(*Continued on page* 78)



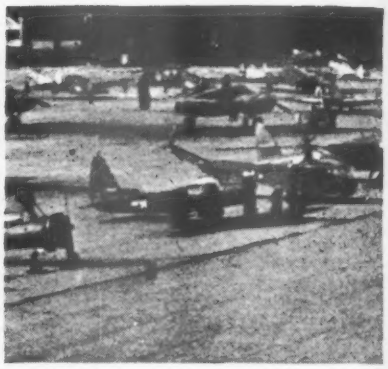
Diagrams represent position of floats, stick and elevators when (A) plane is at rest on water, (B) partially on step in taking off (similar to position for fast taxiing except that stick is back and throttle is less), (C) fully on step and taking off correctly, (D) fully on step but with tail of floats too high, (E) fully on step but floats too low.



Two possible courses in sailing from A to D. In sailing A-B or C-D, the plane drifts backward, tail toward the objective, with engine idling and full left rudder. In sailing A-C or B-D, the plane holds position against the wind with power and full right rudder and drifts sidewise, nose toward objective. Knowledge of sailing fundamentals is very helpful.

Have You Seen?

This is "Lily," portable air strip that can be assembled on the surface of water. A British invention, it consists of coupled hexagonal cans. Dip in runway was caused by passing motor boat.

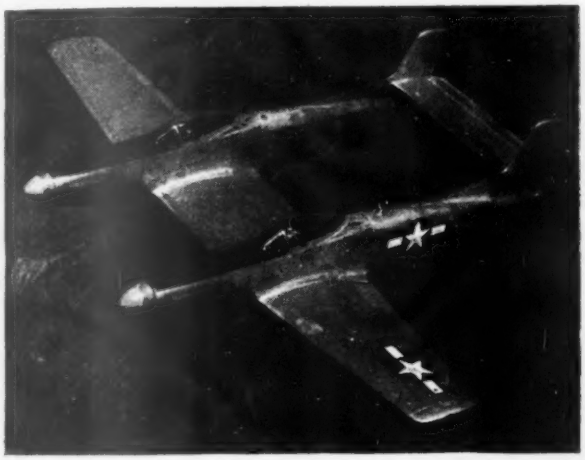


Unusual tricycle-geared monoplane between helicopter and autogiro at Wright Field appears to be a radio-controlled target.

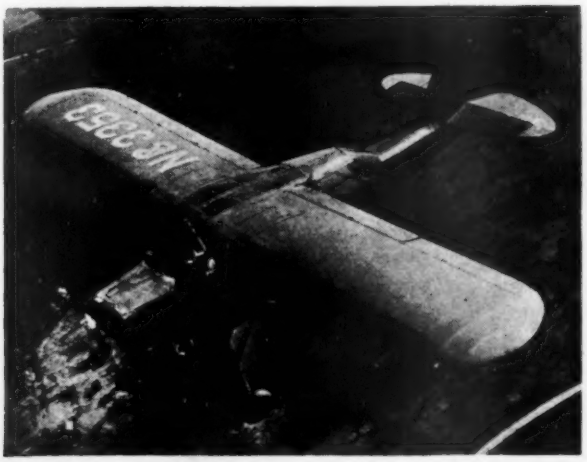
Three-in-one Beetle control eliminates foot pedals, side motion of wheel turning rudder.

Douglas Globemaster (Army C-74, civil DC-7) has four 3,000-h.p. Wasp Majors, cruising speed of 275 m.p.h., range of 7,500 miles. Airliner will carry 96 passengers. Span is 173 ft. 3 in., height 43 ft. 9 in. Overload gross weight is 155,000 pounds. Pan American Airways has ordered 26.

Production Stinson Voyager has 150 h.p., cruising speed of 125 m.p.h., range of 500 miles. Wing span is 34 feet, gross weight is 2,150 pounds. It is four-place, has flaps, and service ceiling is 14,000 feet. Quoted price is $5,000. Voyager 125 was dropped, and tail redesigned for 150.

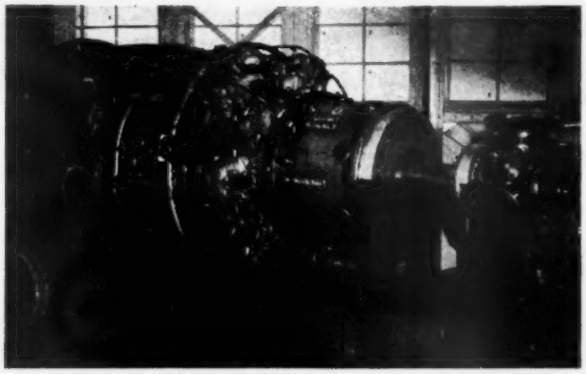


North American XP-82 is a double Mustang, originally intended for long-range missions requiring two pilots. Project has been dropped.



Piper L-14 was new liaison type for Army Air Forces. It had started into production when war ended. It had a large six-cylinder engine.

Army ATC unit in India used elephants to load gasoline drums into cargo planes. This elephant is helping load an AAF Commando (C-46).



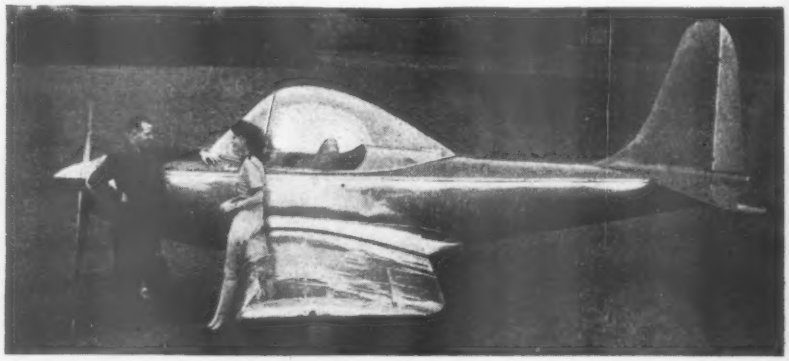
Giant liquid-cooled German aircraft engine develops over 3,300 h.p. It was to have been used in at least one newly-developed fighter.

Have You Seen?

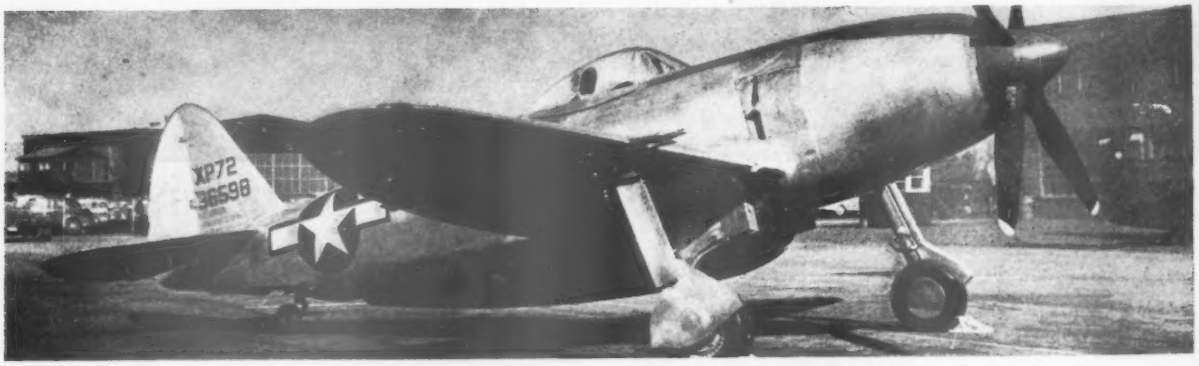
CONTINUED

Experimental Lockheed Lightning (RP-38) at Wright Field had extra cockpit built onto left tail boom behind engine. It was reportedly used to test reactions of pilots to off-center centrifugal forces during combat maneuvers in the air. Such forces might be felt in asymmetrical planes.

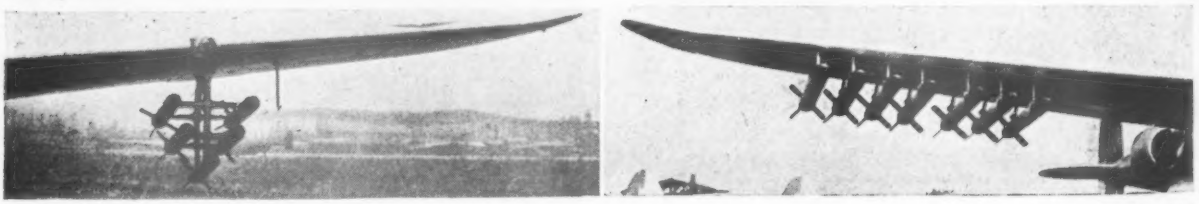
Wildcat landing accident on Pacific isle sent this propeller blade through a tree.



All American Ensign has 85 h.p., tricycle gear and is two-place. Cruising speed is 115 m.p.h., range is 500 miles, landing speed 50 m.p.h. Wing span is 33 feet. Gross weight is 1,450 pounds.



Republic XP-72 was a giant experimental fighter, designed along the lines of the Thunderbolt but a good deal lighter. It had a 3,000-h.p. Wasp Major engine and at one time had a counter-rotating prop. Only three XP-72's were built. One was reported to have clocked over 500 m.p.h. in tests.



These two types of rocket launchers were installed on P-38's when war ended. "Christmas tree" cluster at left enabled plane to carry total of 10 rockets. Installation at right gave P-38 total of 14 rockets but necessitated wing structure change, so "Christmas tree" unit was adopted.

AIRPORT FOR $400

And it took Redmond, Oregon, just one day to do the job.

Three-runway airport, hangar, graded taxi-strip were built by citizens of this community in their spare time on the sagebrush flats of the northwest.

By MARY BROWN

TRANSFORMED from sagebrush flats into a useable landing field in just seven hours one Sunday, Redmond airport has developed into a municipal enterprise.

Redmond's desire for aviation goes back a dozen years or more. Realizing that central Oregon's clear, dry climate, which yields 349 flying days per year, makes the locality ideal for flying, townsfolk laid out a small municipal airport east of the city long before the war. When the Civilian Pilot Training program got under way, the town erected a hangar which was used by a flying service. About that time military men, too, saw the advantages of the strategic location and favorable weather. Construction of a Class Four airport one mile east of Redmond was started by the WPA in January, 1942. The field was later extended by Army engineers.

Soon the Army Air Forces took over Roberts Field, named in honor of the town's aviation leader, J. R. Roberts. Since the city retained ownership, the huge base, with its paved runways, taxiways, parking aprons and operational facilities will again be available for civilian use in the near future.

Because this community, which likes aviation and wanted to fly, found itself without an airport, they decided to build a smaller, auxiliary landing field. The location, five miles west of Redmond, was selected because it was quite level and fairly clear of trees. Dick Ballantine, who had been an

Clearing runway areas, young boys and women aid by loading trucks with sagebrush. Most of the tractors, graders, trucks and bulldozers were donated, manned by Redmondites during airport's construction. Nearby Army air base also aided by lending some equipment.

Hangar framework and sides go up. Of total costs of entire airport, major portion was material cost of hangar: $280. All labor was performed gratis by resident craftsmen and businessmen, including a dentist, dairyman, warehouse operator, grocer, and oil company agent.

Army instructor at Klamath Falls, and who later instructed on a War Training Program, first became interested in the location about a year ago when he looked over the land with Gayle Bartel, Redmond airport commissioner.

The idea germinated: Why not build a field at Cline Falls for use until such time as the Army returned Roberts Field to the city? And, besides, aren't there often smaller auxiliary fields near large ones for the use of student pilots and their puddle-jumpers?

Today, a year or so after the idea began taking shape, Redmond airport has three 200-foot wide runways — the east-west, 3,500 feet long, the north-south, 2,400 feet long, and the northwest-southeast, 2,200 feet in length. In addition, there is a long taxi strip connecting the runways, a large self-setting wind tee and a wind sock, a parking space with tie-downs and a hangar where the planes are kept.

At present there are four airplanes based on the field— a Fairchild "24", two Interstates, and a Taylorcraft. A group of 20 Redmond businessmen and ranchers incorporated as Central Oregon Air Service to provide charter service, using the Fairchild and Dick Ballantine as pilot.

The field received official CAA designation two months after it first was started. A gasoline pump has been installed, and with addition of the charter service, the field now promises turning into a new industry.

The idea of a "jaloppy" airport came spontaneously and, on a broiling August Sunday, when some 30 CAP members and their helpers labored to build a landing field, it seemed to grow in miracle fashion and with unbelieveable speed. It may have seemed a miracle that first day, but it required a lot of preliminary work.

First, use of the necessary land had to be arranged. Redmond-Sisters Sportsmen's club owned 40 acres of the site selected on which sportsmen held trapshoots. But the war had taken their shells and the trapshoot was not then being used.

Additional land was needed, so the permission to use an additional 40 acres was obtained from the Deschutes county court through the help of Judge C. L. Allen and his com-

Mayor T. J. Wells (lower right) and Charles Peters pass a plank to operator Dick Ballantine Army sergeant was a volunteer worker.

Completed hangar and section of taxi-strip. Four planes based at Redmond airport include a Fairchild 24, one Taylorcraft, two Interstates. Flight instruction through flying club membership is given in Interstate, while four-place Fairchild is used for charter service.

Flying ranchers and townsfolk meet at airport on week-end to survey their handiwork—and to fly. With planes lined up on the taxi-strip, Dick Ballantine points out the north-south runway which was lengthened to 2,400 feet. Note completed hanger in background.

missioners. Later, the city of Redmond acquired title to these two 40-acre tracts.

With 80 acres of land ready, Ballantine and the aviation enthusiasts of the town began to consider how to get two runways built. There wasn't money to pay construction costs — but there was the desire of everyone to help. First came the engineering detail of staking out the runways and getting them in line with the prevailing winds. Ballantine's knowledge as a pilot — backed by more than 2,400 hours of flying time — was combined with the skill of Forrest Cooper, resident state highway engineer. Cooper brought his level and transit to the field and did the surveying. It took several evenings, with volunteer chainmen assisting, but the runways were laid out accurately.

Next was the detail of equipment, for Lieutenant Roberts and others knew, that although they were willing to supply manpower, heavy machinery would be needed. Roberts, Cooper and others got in touch with Redmond Army air field and found the commanding officer, post engineer and base adjutant glad to help.

The base sent a large grader and bulldozer to help build the runways, and an employe of the post engineer donated his time to operate it. The city of Redmond helped too, sending out its blade.

Dr. Hal Rogers, Redmond dentist who operates a farm as a hobby, showed up that first day driving a tractor. For seven hours he dragged a land leveler and quack-grass machine owned by James F. Short, warehouse operator and president of Redmond's flying club. J. A. Struss, dairyman, sent his rake to pick up sagebrush. Trucks owned by the workers and others — Short; Gayle Barter, oil company agent; P. M. Houk, garage owner; and Wixson and Crowe, contractors — were there to haul away brush.

Small boys did duty pitching sagebrush into trucks. Ralph H. Hauck, grocery store manager served hot coffee. Maj. R. H. Vincent, command officer of the Army air field, brought cold beverages from the officers club and pool hall owners sent out cold drinks for the thirsty workers.

Things began happening at nine a.m., and by afternoon the field emerged from the cloud of *(Continued on page 112)*

Airplane wind-tee was built by Gayle Bartel (above), oil company local agent and student pilot, in his garage. Mounted on automobile wheels and axle, the canvas-covered self-adjusting device is painted brilliant orange and is balanced by weights within fuselage frame.

SKY SPIES

By JOAN DAVID

Most versatile of the Army's photo planes, the Lightning can carry a noseful of cameras (like the "split 24-inchers" being loaded at left) to altitudes over 40,000 feet. Its speed makes low-altitude runs safer.

There was no evading our air sleuths, even when the Nazis hid their planes underground

ESPIONAGE isn't what it used to be. Of course, Mata Hari's and counter agents still make good motion-picture copy. But 90 per cent of what we learned about enemy activity during World War II was based on the study of aerial photographs.

Much of the credit for that intelligence job has gone to the camera pilots—the men who risked their lives in a twisting, turning evasive race with death to bring back the pictures. But that is only part of the story. The rest concerns the photo interpreter (the P.I.), the other half of the sky-spy team who

Suspicion of military activity in the Grosseutersdorf, Germany area was aroused by this high-altitude shot taken mid-summer, 1945. The reasoning: (1) heavily-traveled roadways do not end on mountainsides; (2) villagers do not require two super-highways to get to a given point; (3) buildings hidden among trees or (4) arranged in neat rows smack of the military; and (5) new railroad siding spells enlarged freight terminus.

spent day after day in an eye-straining study of these photos This is a story of that work. But first, a concrete illustration:

It was through a comparative study of aerial photos, for example, that P.I.'s discovered and followed the development of one of Mr. Goering's pet projects, the only underground factory which produced completed Me-262 jet fighters. Pilots making long-range bombing flights into Germany first noticed something unusual going on near Kahla and Grosseutersdorf, at the base of a mountain known as Walpersberg, late in 1943. Reconnaisance pictures revealed a number of tunnel entrances apparently leading into the mountain. Subsequently, the project was photographed at regular intervals. A few of those pictures have just been released from the War Department's files for use in this article.

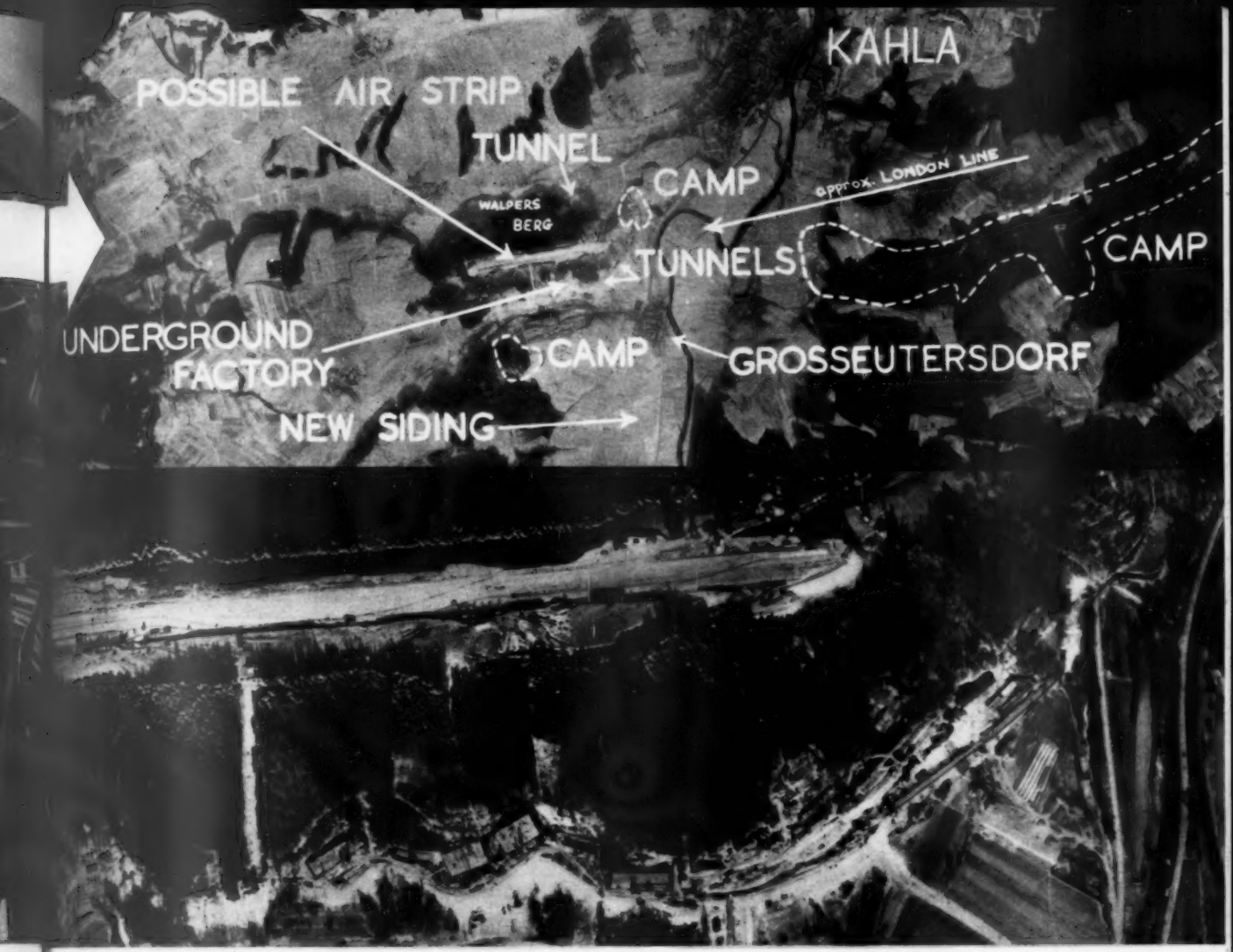
The first thing a P.I. looks for in an aerial photo is some sign of new activity. By August 15th, 1944, when the first aerial photo shown in this series (above) was taken, work had progressed enough so that even a cursory glance would make a P.I. highly suspicious. The white patch of roadway showing just below and to the right of No. 1 (near Grosseutersdorf) was a dead giveaway. It contrasts sharply with the narrow winding roads which ribbon through the rest of the countryside. It was an irregular, rather wide, scarred surface of which at least three points appeared to start up the heavily wooded mountainside, something no reasonable road would do. Two roads that branch at No. 2 were wide enough for heavy truck travel from the village (Grosseutersdorf) to the project at No. 1. The shorter road dissected neatly laid out farms—thus proving its newness—and entered the main road in a delta-like network of tracks which shows that they were probably prefabricated.

At No. 3 buildings could be seen through the tree tops. It was surmised that this was one of the camps used to house the slave labor which tunnelled through the mountain to build the underground factory. The neatly lined up buildings at No. 4 were fronted by a maze of little roads. They are probably storage or repair depots.

Just to the left of No. 5 is a new railroad track leading into Grosseutersdorf. It was already in use, as shown by the four small worms of trains on it. The new track, like all new digging, shows up light on the photo and might easily have been taken for a road. If there is no other clue, P.I.'s look first at the curves of a new road. Automobile roads are apt to have sharp curves and jogs; railroad tracks can only have wide angle curves. Here traffic was so heavy on the new railroad that a small scale marshalling yard had been developed where it branched off the older, darker line to the right of No. 5.

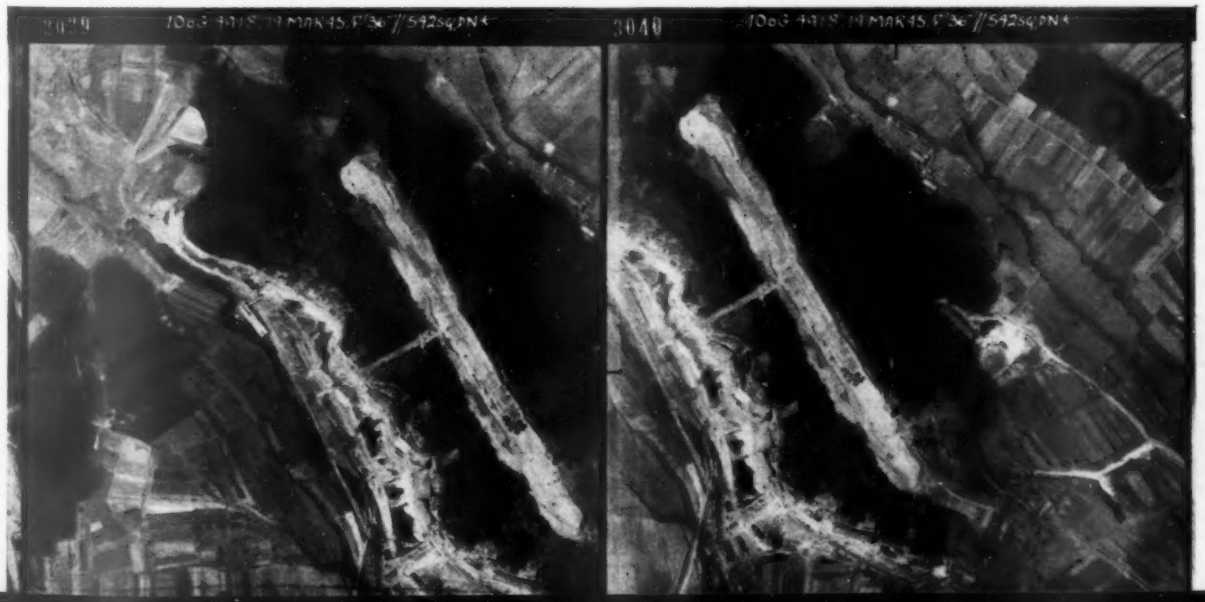
A P.I. looking at this picture would be suspicious too of the wisp of a road just visible through the trees above No. 1. A road going right along the length of a mountaintop is considered irregular.

By December 26, it was quite apparent what was being done and written reports evidently accompanied these annotated photos (page 41). The camp at the right (upper photo) en-

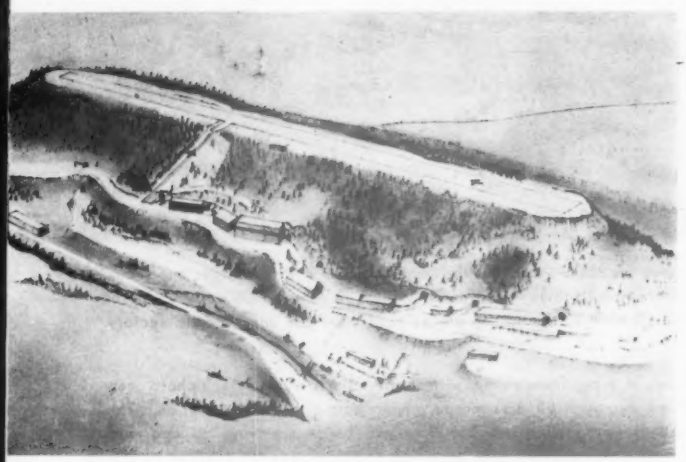


Confirmation of PI deductions was made on subsequent photo runs. Of these two shots—made on the same day late in 1944—upper one shows surface installations of the jet-plane factory and traces outline of the slave-labor camp (right)—one of Nazi's largest, housing 12,000 workers. Lower photo, taken at low altitude, shows details of the air strip and the cog-road (left) used for lifting planes to it from the underground factory.

Stereoptics play an important role in photo interpretation. Pictures are taken in a continuous strip, with shutters timed so that each photo overlaps the preceding one 60 per cent. Placed under a stereoscope and magnified, two such pictures merge, giving normal depth perception. This "stereo pair," taken early in 1945, shows the Grosseutersdorf factory already in production Two Me-262's can be seen moving up cog-road.



Equipment used by the photo interpreter includes stereoscope, slide-rule, engineer's metric scale, T-square. Measurements are calculated in ratio to some known object, or from height, speed and time at which photo is taken. PI accuracy is uncanny. An expert in armament, for instance, can give the precise caliber of a gun when the entire emplacement appears to the novice as a tiny blotch no larger than this exclamation point!



PI accuracy is graphically illustrated in this perspective drawing of the Grosseutersdorf project made months before its capture by Allied forces. Cog-road and tunnel openings (arrow) were scaled to the inch.

Post-war shot of a tunnel entrance to the underground factory further indicates accuracy of drawing at left. Burned out by the Nazis, little more could be learned of the project than our sky spies already knew.

closed with the dotted line was one of the largest labor camps in all Germany. It housed 12,000 slaves.

The low-level shot taken the same day showed the mountainside project in detail, although it still was difficult to interpret because of the elongated shadows cast by trees and buildings. The picture must have been taken about 4 p.m. In contrast to the first two pictures, which were vertical shots, this one apparently was an oblique. In prints of these photographs, which accompany this article, you can see the landing strip on the mountaintop almost completed. The threadlike lines crossing it at different angles are tracks for the little dolly cars which carry the dirt from the middle to fill in the sides and make the airstrip wider. The straight road leading right up the side of the mountain to the landing strip is the bed for a narrow gauge cog railway along which complete jet planes were towed up to the field. P.I.'s learned by watching construction phases of the buildings at the base of the mountain that they were reinforced concrete 18 feet thick, and quite immune to attacks by any bombs we were using at that time. Until the project was finished it was not worth an aerial assault.

Just to the right of several of the buildings, as well as to the right of the cog railway bed, are short roads ending in pinpoint-black spots. These are apparently the tunnel entrances to the underground factory. There were about 15 of them altogether. Supplies went in through them and parts came out ready for assembly in the concrete sheds. When this picture was made the little railway tracks which connected each shed and tunnel to a main line which snakes along the edge of the whole development had already been installed and (under magnification) cars can be seen on them.

On March 19 of this year, when the next two pictures (the

(Continued on page **106** *)*

STRATEGIC AIR VICTORY IN EUROPE

How did our strategic air forces win the air war over Europe? In this historic 16-page document, FLYING brings you an official account of the theory, methods and results of the RAF and AAF.

OUR STRATEGIC BOMBING BROKE GERMANY

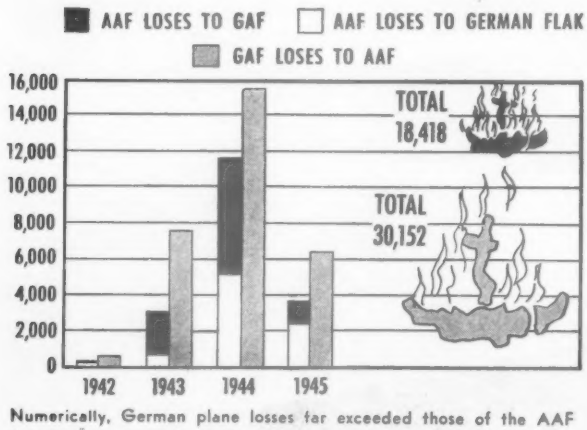
These 16 pages are reprinted from a special edition of Impact, *the hitherto classified AAF publication. They are devoted solely to describing the co-ordinated strategic bombing effort over Europe of the U.S. 8th and 15th Air Forces and the RAF Bomber Command. Next month we will reprint a similar section on the tactical air war.*

IN PAST wars it has always been necessary to dispose of an enemy army before being able to destroy, occupy or dictate terms to the enemy nation, which, in the last analysis, is the real foe. The recent European war was unlike all others in that this time the enemy nation was destroyed almost ahead of the army which was supposed to defend it. This reprint from *Impact* attempts to show how such an extraordinary paradox was brought about.

For the second time in a generation Germany has been defeated by a coalition of Allied powers. For the second time her armies have met their opponents in a series of huge and bloody engagements on two fronts, have won notable victories, but in the end have been vanquished. In these respects the two wars were similar. Fundamentally, however, they were utterly different. In the first none of the fighting was done on German soil. German civilians, except for suffering hunger and deprivation as the result of blockade, were untouched by war.

Their cities and factories emerged unscathed. Their armies marched home with bands playing and flags flying, and were able to launch the illusion that they had not been really defeated, an illusion which was to be of inestimable value in preparing the people for the next adventure. But this time they had no such luck. They were faced with a weapon which could leap over battle lines and frontiers and smash at the ultimate enemy (the German workman who fed and equipped the German soldier) in his own home. The home front felt the shock of bombs soon after Britain entered the war. These shocks multiplied in intensity thereafter, continuing almost daily for five and a half years, at the end of which time Germany had literally ceased to exist as an organized industrial community.

The concept behind this campaign of destruction was born a long time ago. It existed in very crude form in the last war. In fact, so crude was bombing then that the idea of developing it to play a leading part in the military planning of nations was largely discarded in the nineteen twenties. This does not mean that nations were not airminded. Far from it. The major powers, Britain, Russia, France, Germany, Italy, Japan, and the United States, all had air forces. As technical advances were made, these air forces became larger and more versatile. Generally speaking, however, they continued to remain mere adjuncts to the ground and naval forces, and the design and employment of aircraft were such that those air forces could only supplement ground and naval operations. In other words, they were primarily tactical, not strategic, weapons.



Numerically, German plane losses far exceeded those of the AAF but they were mostly fighters, while ours included many bombers.

There were two notable exceptions to this. The British, sensing the potentialities of air, created an independent air force. But being more concerned with defensive than with offensive plans, they concentrated mainly on fighters. It was only in the United States that the germ of strategic bombing was kept alive. It is hard to realize today how feebly the flame of life flickered in that germ. The American Army was small and lacking in influence, considering the size and importance of its mother country. Within that tiny army was an even tinier Air Corps to which nobody paid much attention. Finally, within the Air Corps itself was a handful of "fanatics" who were not as interested in being hot pilots (in those days you were a hot pilot or nothing) as they were in the problems of constructing aerial freight cars which would carry a load of bombs to a target and drop them on that target. Even less attention was paid to them.

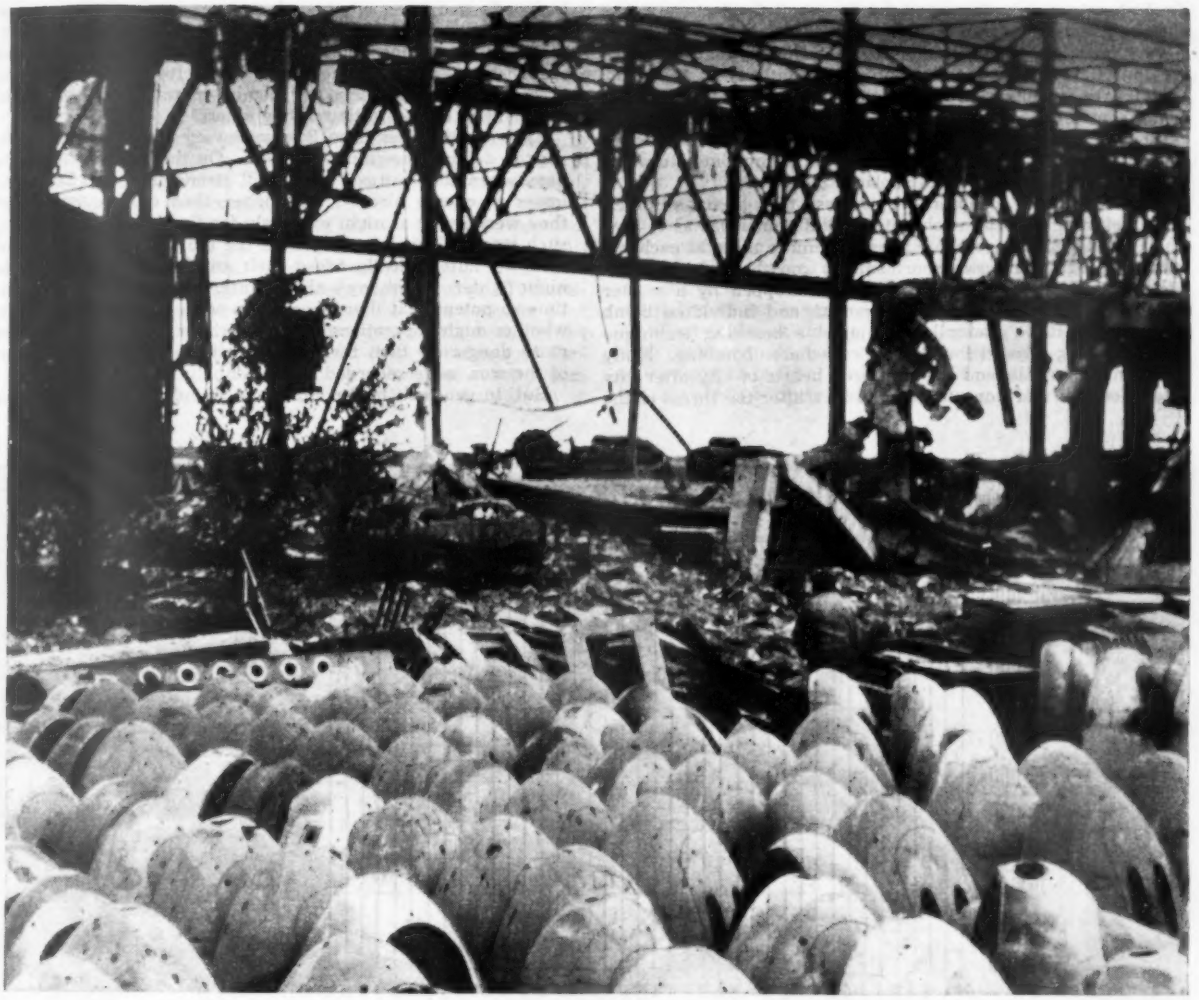
But they stuck to their knitting. They procured a bomb sight which satisfied their requirements for accuracy. They wangled an appropriation for a four-engined bomber, the *Fortress*. When it was built they went on good-will flights to see how it stood up on long missions under trying conditions. And all the time they applied their growing experience to the evolution of a wild and woolly theory which, if it proved valid, would revolutionize warfare. That theory bluntly stated that sooner or later it would be possible to build a fleet of bombers which by themselves could reduce the vital industries of an enemy country to ashes.

And that is just what they did, launching their attacks from England in the north and Italy in the south. Germany today presents a spectacle which defies description. Her bridges are down, her canals ruptured, her harbors clogged, her rail yards pitted, many of her factories blasted and silent, her cities gutted. Wherever Germans gathered to build things or even to live together in large numbers may now be found scenes of desolation like those on the face of the moon. It is safe to say that at no time since the locust-like days of the Tartars has the physical property of a nation been ground into such small and useless fragments.

Germany declared war on us on December 11, 1941. At that time the whole of Europe had either been conquered by her or was dependent on her economically. An efficient but savage program of exploiting the manpower and resources of this vast area was strengthening her daily, and it was clear that she could beat off conventional ground attacks indefinitely from the west, even assuming that it were possible to launch such attacks. It was in this difficult and unpromising atmosphere that American and British leaders met to formulate a program for defeating Germany.

The location of England provided the key. England lay within flying distance of enemy country. It had lived through one invasion threat during the Battle of Britain and could probably resist others. It was planned to convert it into a vast air base, and to launch streams of bombers from it against German industry until they had so weakened the enemy's ability to equip and maintain her armies that a direct ground invasion would have some chance of success.

It sounds easy now, but this decision was reached at a time



Messerschmitt Me-110 noses point toward the sky in this roofless factory at Furth. Eighth Air Force heavies hit this plant for the first time on February 25, 1944. It was painfully rebuilt, then bombed again a year later with the results shown here.

when the German failure to bomb England out of the war had convinced many military minds that bombing could never be conclusive. The British themselves did not believe that daylight bombing could be carried out without prohibitive losses, and as a result the planes of the RAF Bomber Command were modified to fly at night. Inasmuch as it is very difficult to pick up pinpoint targets at night with conventional visual sighting equipment, they evolved a doctrine calling for saturation attacks against large cities, which *can* be located in darkness by various methods. By attacking such areas they hoped, through the laws of chance, to damage or destroy many of the industrial installations which are crowded into all large cities. Further, they hoped so to interfere with the normal life of the German workman that his value as a producer of war equipment would go way down. This was expected to occur when houses and local transportation systems were destroyed, when cooking and food distribution ran into snags, when lighting, water and sewage facilities were crippled, when sleep was interfered with night after night and, finally, when part of the labor force was itself killed by bombing.

This is not the most economical way to expend a given quantity of bombs, but under the limitations mentioned above, it was the *only* way the British could hit back at their enemies. It was not long before they had become wondrously efficient at blotting out large targets. To supplement this work, the Americans undertook to fly against Germany by day. Their bombers would be heavily armed and armored to defend themselves against the *Luftwaffe*, their range would be greater, and as a result they would not be able to carry as heavy loads as the planes of the RAF. But the Americans were confident that they could compensate for this by aiming *every bomb* at a selected industrial pinpoint. The real virtue of the American method was that if the proper targets were chosen it might be possible to cripple German industrial and military power through the destruction of only one or two key industries (such as oil or transportation) without which the military economy as a whole would be unable to operate. It was seriously doubted in many quarters that the Americans could fulfill their half of the commitment.

Nevertheless, the Combined Bomber Offensive was laid on.

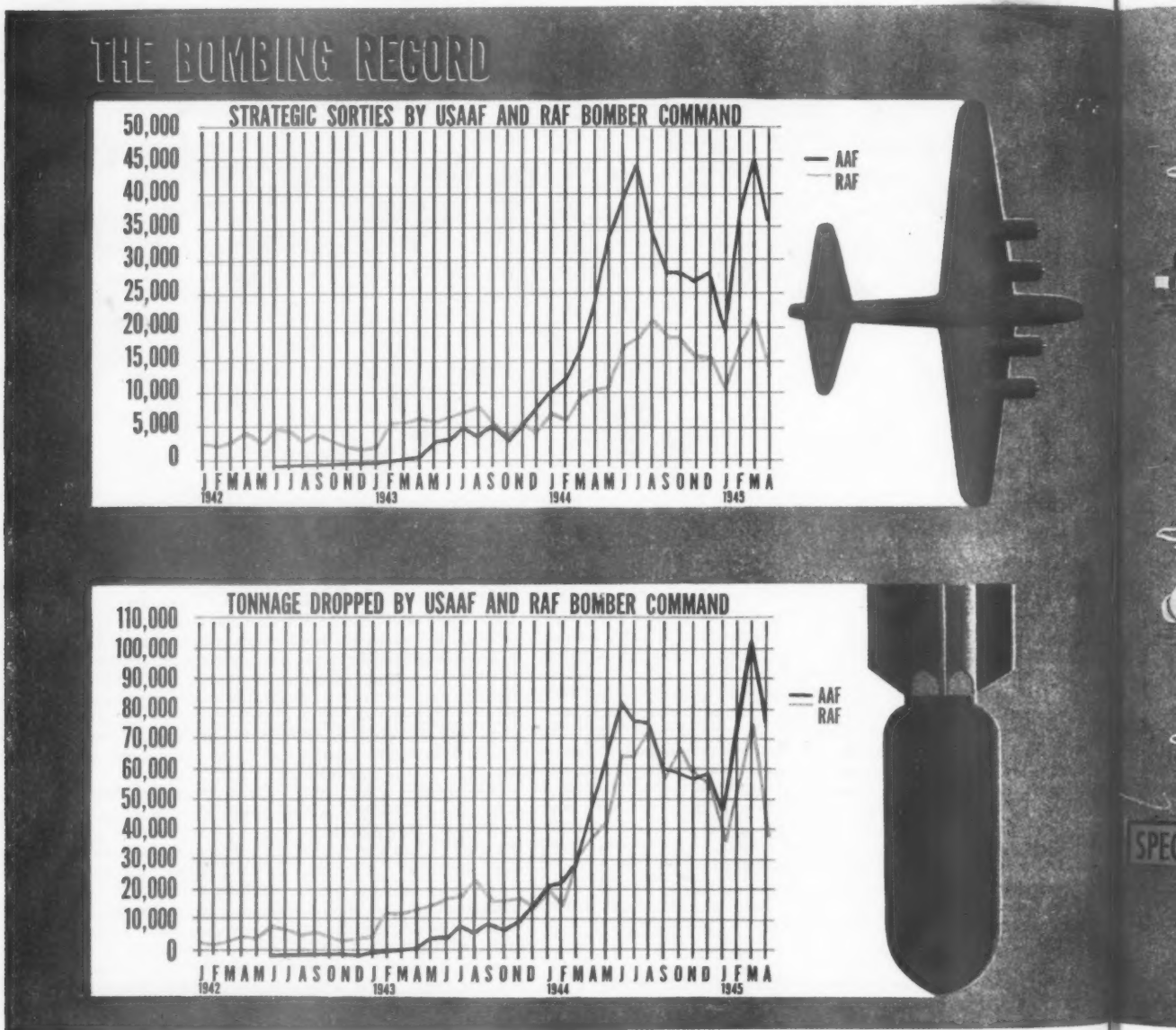
In concept it was something more than mere day and night operations. Each air force was expected to do something that the other could not do as well. American heavies would destroy the major industries on the fringes of a city, and the RAF would destroy the city itself, together with a substantial number of smaller factories situated in it. As the two bomber forces grew in size, this is exactly what happened. The combined effort resulted in the virtual elimination of place after place as producing centers. At Magdeburg, for example, the 8th Air Force went after the top-priority synthetic gasoline plant at Rothensee, the Junkers aircraft engine plant, the Krupp armament works at Buckau, and an ordnance depot at Friedrichstadt where the weapons produced at Buckau were collected for distribution to the 6th Panzer Army and other combat units on both the Western and Eastern fronts. The RAF followed this up by destruction of the urban core. This

final phase not only destroyed the houses of the factory workmen and snarled up transport, but, more important still, leveled a very large part of the remaining factories in this highly developed industrial center. In an armament city of this kind, most of the industries are interdependent, one upon the other, using common sources of power, raw materials and transport, with many smaller plants making parts for final assembly of weapons in the larger ones. It takes a joint pinpoint-saturation technique to knock out such a place.

It is interesting to observe that these two great air forces, which started out with such entirely different ideas as to how they should operate, became more and more alike as each began to recognize its own shortcomings and the virtues of the other's methods. By the use of flares dropped by a master bombardier, special sighting equipment, and individual bomb release, the RAF gradually developed a bombing technique which no longer could correctly be called area bombing. Many rail centers, canals, and the shattered hearts of city after city bear eloquent testmony to this. In fact, after the threat of the *Luftwaffe* had been eliminated, permitting the lightly armed *Lancasters* and *Halifaxes* to operate in safety during daylight, the RAF flew some enormously damaging pinpoint missions against the German synthetic oil plants. Its practice of having each plane fly separately and bomb separately multiplied the problems of enemy antiaircraft gunners.

As a result, losses from flak were very low, considering the rugged defenses around oil targets. On the other hand, in the days when the *Luftwaffe* was still strong, Bomber Command losses to enemy aircraft ran higher than ours, even though they were flying at night expressly for the purpose of avoiding such losses. This merely proves the old rule that in all wars weapons automatically breed their antidotes—in this case the night fighter. Germany's night fighter organization was at one time so potent that there was grave concern in the RAF as to whether night operations could continue. They had become more dangerous than the daylight attacks which, at the start of the war, were regarded as suicidal.

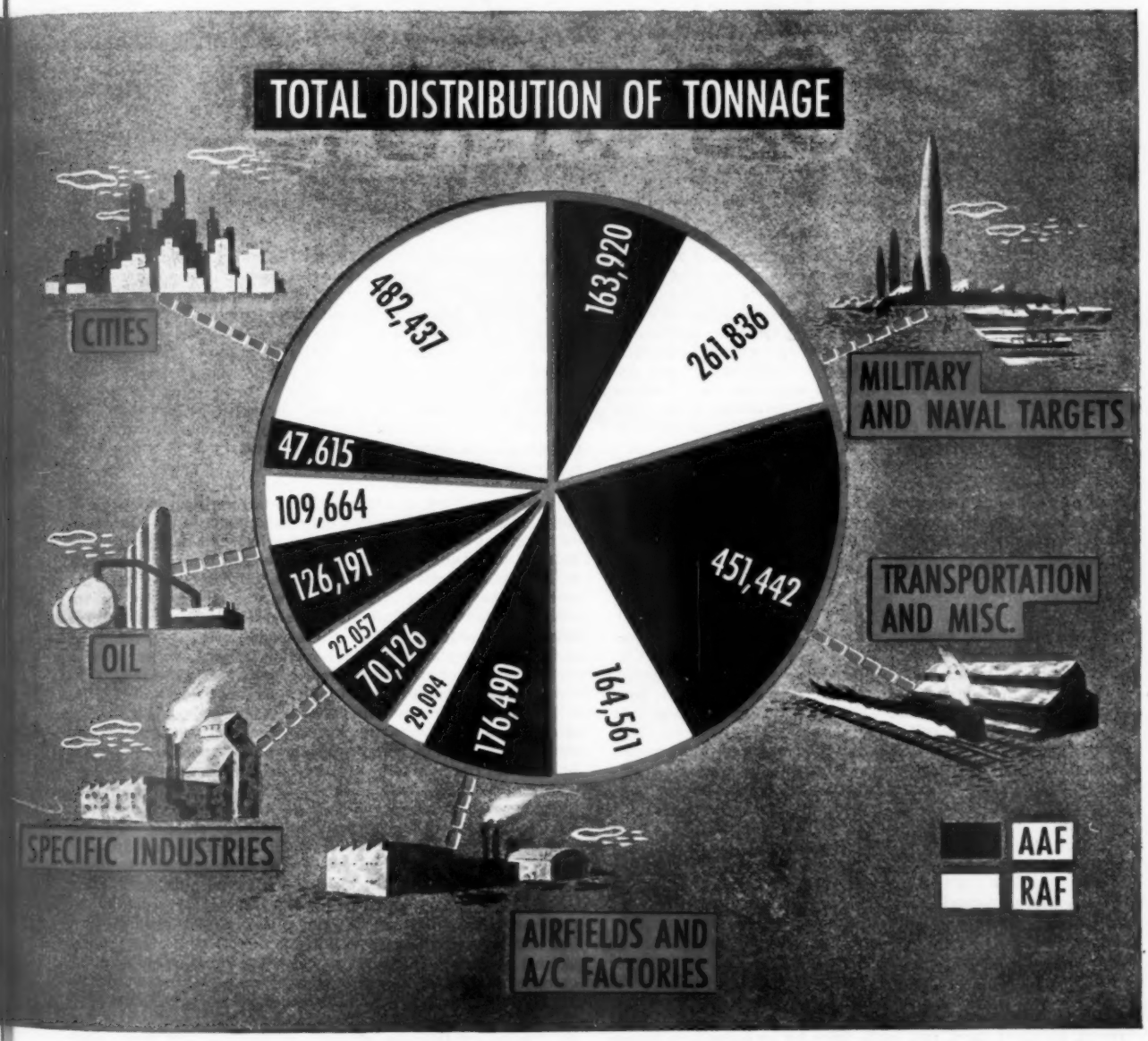
But, to get back to the story, the island air base mentioned



This chart compares the strategic sorties and bomb tonnage dropped by U. S. strategic air forces and the RAF Bomber Command over Europe. USSTAF figures include bombs dropped in the Middle East and Northwest African theatres, while available RAF figures apply only to Bomber Command operations from England. The chart indicates how U. S. operations soon caught up with those of RAF.

above had geographical disadvantages as well as advantages. Every bomb we proposed to use there, every soldier, every drop of gas, every replacement part, everything but the bombers themselves, which could be flown, had to be shipped over 3,000 miles of ocean from the United States. As a result, the first task of the infant 8th Air Force was to bomb German U-boat yards, for the submarine was then such a menace to shipping in the Atlantic that, unless it could be controlled, it would take us forever to build up a bomber force large enough to be effective. Accordingly, the 8th got its first real taste of warfare during attacks at Lorient, St. Nazaire and Brest, coordinating its blows with missions by the RAF to Kiel, Wilhelmshaven and Bremen. These in themselves were not conclusive. Germany had great numbers of submarines. Her construction and repair were done largely in huge concrete pens which were almost impervious to the type of bomb which the Allies were then using. All together, the campaign cost Germany something under 15 per cent in submarine construction, plus a general lowering of the number of subs operational at any given time, by lengthening the time necessary for reconditioning and refitting. The real payoff, also by air, came from the provision of an umbrella of protective planes over the convoys themselves, which, together with the blows at construction and the activities of the RAF Coastal Command, enabled our ground and air forces in England to grow. However, it was not until the summer of 1943 that the 8th was large enough to set out on missions against critical targets deep in Germany itself. By November, 1943, a growing 15th Air Force was based in southern Italy.

The first target system of fundamental importance which was assigned to the 8th and 15th was the German aircraft industry. The enemy, belatedly realizing the disaster awaiting him if our bomber forces could carry out their proposed program, had begun to expand his production of fighter aircraft in an effort to knock us out of the sky. If we were to proceed with the dismantling of her industry, the *Lufftwaffe* would have to be disposed of first. This called for pinpoint bombing of the highest order, because most aircraft plants were located in the



And here are the targets. Study of this chart reveals not only the different target emphasis of RAF and AAF, but the different theories of bombing. U. S. Air Forces tended to concentrate on specific classifications of industrial targets; the RAF bombed "cities", reflecting its emphasis on area bombing techniques, and "military installations and naval targets."

By 1942, Germans had developed three big complexes for producing Messerschmitt Me-109's, reflecting a shift from bomber to fighter production. Idea of centralizing fighter manufacture was too late.

The dispersal of Me-109 industry was achieved by 1944 after the complexes had been bombed out. Production jumped to a new high of 1,400 in April but the Germans lacked fuel and trained pilots.

suburbs of large cities or else out in the country, and were not seriously affected by the saturation attacks of the RAF. The ensuing struggle for the mastery of the air went on for about a year. For details, see accompanying photographs. We absorbed some fearful pastings and for a time were consuming our entire 8th Air Force in battle at the rate of two and a half times a year. By the spring of 1944, however, just in time for the Normandy invasion, the *Luftwaffe* was done for. It never seriously interfered with our ground operations in Europe. Our plane losses due to enemy air action dwindled to insignificant proportions.

In March, 1944, aircraft production ceased to be No. 1 priority, further attacks being largely of a policing nature. Its place was taken by transportation. In addition to clogging the movement of enemy troops to parry our invasion thrust, the blows at rail centers had the benefit of being indirect blows at all industry. This is because, in a highly industrialized nation like Germany, coal, steel, heavy chemicals, petroleum and many other products must be shipped to the manufacturing centers before any production of finished goods can be achieved. The effects of the transportation campaign were slow in making themselves felt due to the fact that the rail network in northwest Europe was the most highly developed in the world. It took many months of slogging through excess capacity, both in trackage and rolling stock, before the Germans began to experience serious difficulties in moving goods from one place to another. However, the statements of captured military and industrial leaders testify to the over-all effectiveness of a campaign which for a long time appeared to be wasted effort. Germany kept her rail system in operation until the end of the war, but only through the most superhuman efforts, all of which meant the withdrawal from the army and other industry of an enormous amount of thought, manpower and material, at a time when all of these could least be spared. And, despite these sacrifices, Germany fought the last six months of the war with a rail system wholly inadequate to her needs.

In May, 1944, transportation fell to second priority for the American Air Forces, its place being taken by oil. As a matter of actual fact, this meant only a slight reduction of the effort expended on rail yards. The reason for this is that these targets are easy to find, easy to hit and hard to defend. As a result, on many days, rail yards were hit as secondary targets by formations which had been weathered out of their primary targets. And all through this period the RAF continued to deal out tremendous blows of its own against rails.

The oil campaign proved to be the most immediately catastrophic of all to German hopes. It immobilized the remnants of the *Luftwaffe*. It stalled the *Wehrmacht*. It forced the home front, already clogged by the rail campaign, to rely on charcoal-burning and horse-drawn vehicles. It was the most fiercely protected of all German industrial systems. Refineries were ringed with dense concentrations of flak, and the dying GAF seldom rose to oppose our missions unless when they were directed at oil targets. In view of the immense success of this campaign, it is reasonable to ask why we didn't go after oil earlier. The answer is that it was necessary to beat down the *Luftwaffe* before we could strike at other targets. If we had not done so, our battle attrition might well have been so high that the assembling of a large enough bomber force for decisive daily blows might have been deferred indefinitely. Therefore, oil could not be considered for first priority until the spring of 1944. It might then have been put ahead of transportation, but the demands of the ground forces for a rail campaign to implement the looming Normandy invasion deferred it for another two months. Rail attacks could be expected to have immediate tactical results, whereas destruction of refineries and synthetic plants would be effective only when several months' stocks of already produced fuel were exhausted.

As a sort of somber undertone to this symphony of aircraft-rail-oil destruction, the Allies conducted a continuing campaign against German manufacturing in general. The Ruhr, which was one expanse of heavy industry and heavier flak, became known as "Happy Valley" to the RAF, whose bombers visited it several hundred times in the course of the war. In addition they sapped the energies of factories and machine shops of all kinds in the cities they were methodically erasing. The 8th and 15th went after the rest. Ballbearing production at Schweinfurt was attacked. So were tank and truck plants, rubber plants, ordnance plants, storage depots, locomotive works. But many industries were scarcely touched, in accordance with American strategic doctrine. It was thought to be, and it proved, unnecessary to launch continued attacks against aluminum production, electric power, chemicals, machine tools and other industrial systems. The dry rot in the bombed systems was affecting the entire tree. German production began to take sudden and terrifying downward swoops. By the fall of 1944 the economy as a whole was badly shattered. It absorbed even more grievous blows during the winter, by which time the German armies were suffering from so many shortages that they were to offer only disorganized re-

Bombing forced the Hun aircraft factories underground. By early 1944 the program was well along, with sites allocated by a central planning organization. At least 80 plants have been found—this one is an He-162 jet plane factory in a salt mine at Egeln.

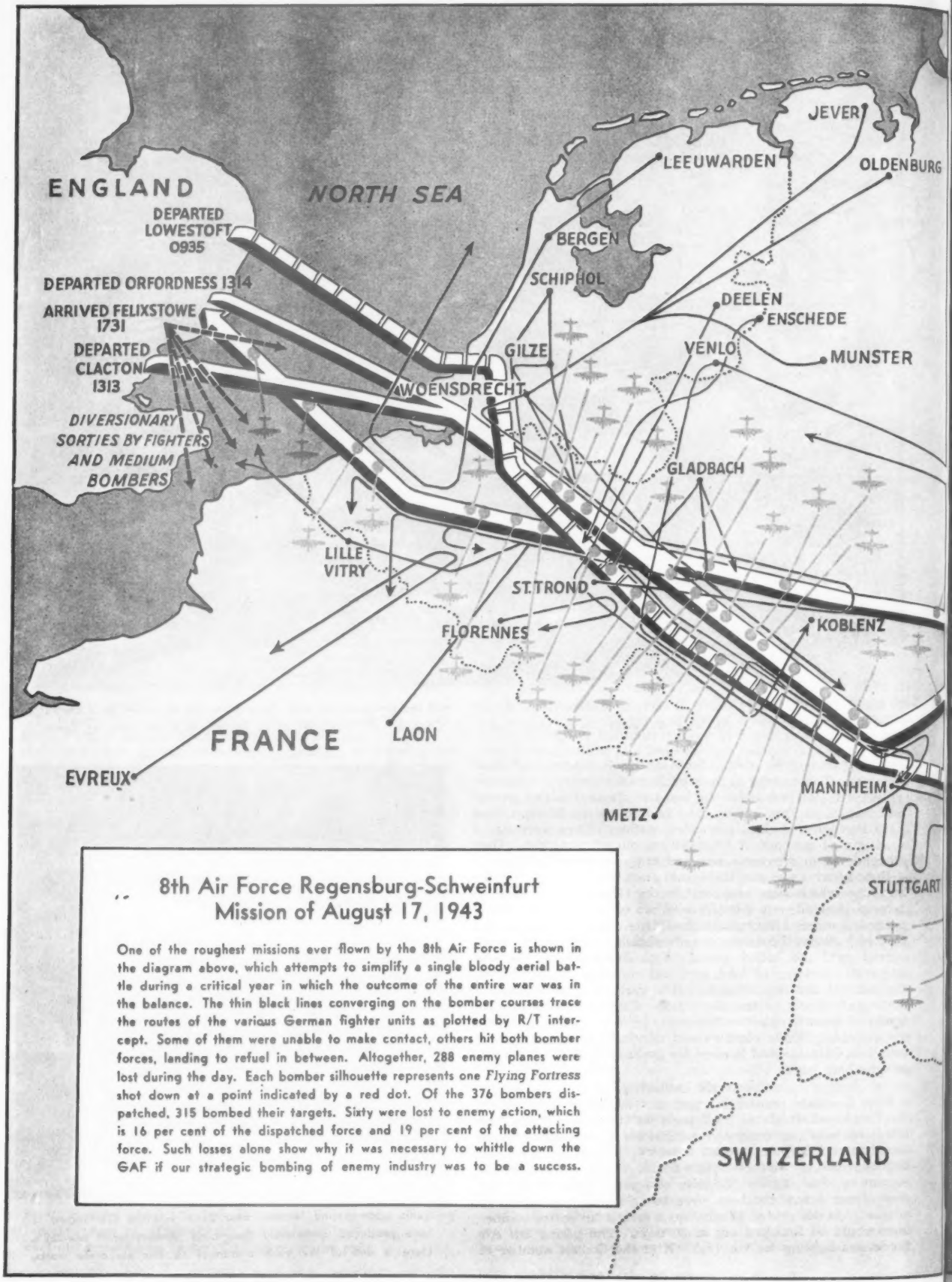
sistance, once their final effort in the Ardennes had been defeated. The country at their backs had become an industrial graveyard. Reeling under the hammer blows of Allied ground and tactical air forces, they retreated across the Rhine, falling back through one ghost city after another. They were out of food, out of gas, out of ammunition, out of transport. They surrendered in droves—a wrecked army in a wrecked nation.

Nobody who was not there can grasp the scope of the destruction which was meted out to the Germans. Of their 50 largest cities, all were from 30 to 80 per cent destroyed. Dazed citizens wandered through crooked little paths which they had cleared between the mountains of rubbish. Looting was widespread until the Allied military took over, emphasizing the universal shortages of food, fuel and clothing. The factories, the patched and repatched factories were silent, their twisted metal guts slowly rusting in the sun. Children played on the tracks of the otherwise motionless rail yards. Sheep gazed on the airfields. Of the complex and wonderful edifice on which countless Germans had labored for generations, little remained but the bare bones.

Aircraft Industry

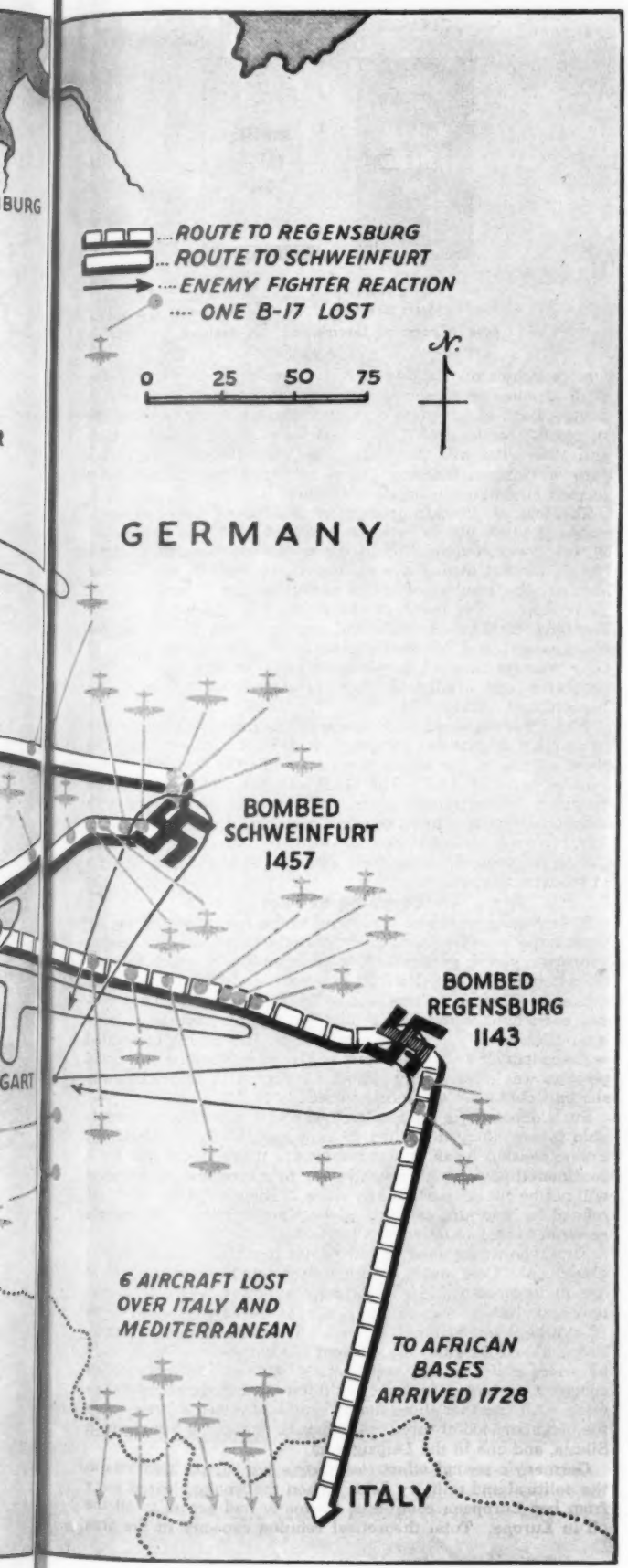
With the plain percept in mind that first things come first, the Combined Chiefs of Staff early in 1943 ordered the first intensive bombing campaign against strategic targets to be aimed at the German aircraft industry. Opposition from the *Luftwaffe* had grown increasingly fierce. In our earliest attacks —many of them against German sub pens—eight to ten per cent of our heavy bombers were being shot down on every mission. At the rate of 10 missions a month, an entire bomber force could be knocked out in 30 days. The young 8th Air Force was fighting for survival. With the limited number of

Kahla underground factory, near Jena, was the first known to have produced completely assembled Messerschmitt Me-262's. Here is one of the cave entrances to this elaborate works.



8th Air Force Regensburg-Schweinfurt Mission of August 17, 1943

One of the roughest missions ever flown by the 8th Air Force is shown in the diagram above, which attempts to simplify a single bloody aerial battle during a critical year in which the outcome of the entire war was in the balance. The thin black lines converging on the bomber courses trace the routes of the various German fighter units as plotted by R/T intercept. Some of them were unable to make contact, others hit both bomber forces, landing to refuel in between. Altogether, 288 enemy planes were lost during the day. Each bomber silhouette represents one *Flying Fortress* shot down at a point indicated by a red dot. Of the 376 bombers dispatched, 315 bombed their targets. Sixty were lost to enemy action, which is 16 per cent of the dispatched force and 19 per cent of the attacking force. Such losses alone show why it was necessary to whittle down the GAF if our strategic bombing of enemy industry was to be a success.



planes we had on hand something had to be done, done quickly and where it would hurt most.

It was clear, too, that the success of future strategic campaigns and invasion of the continent depended on eliminating the *Luftwaffe*. The aircraft industry was then centered in a few big complexes. By hitting assembly plants, the number of planes the *Luftwaffe* could put in the air would be reduced in a matter of weeks. And time was of the essence.

At the start, numerical inferiority and the lack of long-range fighter escort put the 8th Air Force behind the eight ball. But there was no question that our planes and crews were more than equal to the task. The history of U. S. air power will always honor the bloody summer of 1943.

At Warnemunde on July 29, for example, the fighter aircraft and assembly factory, making mostly Focke-Wulf Fw-190's, was attacked by 54 *Fortresses*. Eighteen of 27 buildings were destroyed. We lost only two *Forts*. One day earlier at Oschersleben, on the deepest penetration into Germany up to that date, 28 *Forts* found an important fighter plant which turned out 50 Fw-190's a month—21.7 per cent of the total output. We destroyed 48 enemy fighters in combat. We lost 15 *Forts*. Fifteen out of 28!

But the feel and flavor of those first battles are best summed up in a transcript of an extemporaneous interview given at AAFSAT by Lieut. Col. Beirne Lay, Jr., who was a co-pilot and special observer on the Regensburg mission of August 17. (The Messerschmitt Me-109 assembly shops at Regensburg accounted for 30 per cent of German fighter production.) This double-header mission made history because it was the largest force sent out by the 8th Air Force to date, and because it was the first big shuttle mission. The larger part of the force hit the ball bearing plants at Schweinfurt, then returned to its base. The other task force (147 *Fortresses*) hit Regensburg, then wound up in Algeria.

Here are some excerpts from the interview:

"We were to operate with three groups in the first combat wing, two groups in the second and third combat wings. I was in the low group in the third wing. We were told we'd have *Thunderbolt* escort picking us up at Eupen and carrying us through the fighter belt. The *Thunderbolts* were not yet carrying 300-gallon belly tanks—they had just started using belly tanks and were carrying only 100 gallons—so that meant we wouldn't have support at the target.

"We assembled on time. . . . As soon as we got up to base altitude (17,000 feet for the third wing), we were well within the German RDF screen, which has a range of about 150 miles at that altitude. So the whole German defense machinery was beginning to warm up in front of us.

"To counteract our diversionary feints the Germans had set up a fluid defense. By the time we crossed the enemy coast, they were reporting us once every minute, and could get a pretty good idea where we were headed; furthermore, they knew we had to follow a rather direct course coming home, because of our fuel limitations. So they could pull fighters from as far north as Denmark and from down around Paris, Poix and Lille, and send them after us.

"We encountered the first fighter opposition at Eupen, just inside Germany, which was where our fighter cover was supposed to be. We didn't see any fighter cover; it must have been awfully high. Our column was about 15 miles long and the fighters may have been giving protection up around the first two combat wings. They certainly weren't helping us any in the trailing wing.

"Shortly after we were supposed to have made a rendezvous with the *Thunderbolts*, the attacks started. Focke-Wulfs and Messerschmitts came in from every direction, making coordinated attacks. Therefore there could be very little evasive action within the group. I believe those attacks were more intense than any we had met up to then. There were more than 200 fighter attacks from there to the target.

"They used 20-mm time-fused cannon shells. They made the first fairly large-scale use of rockets. And there was some air-to-air bombing. Flak was negligible. By the time we got close to the IP (initial point) we had lost 17 planes, nine of them shot out of my group, which took more than half the loss of the whole force, giving some indication of where those fighters were making their attacks.

"Weather at the IP was perfect. . . . The fighter opposition died off just before we got to the target. I don't know why, un-

less they just ran out of fighters. The bombing was excellent. I saw only one bomb wasted.

"The boys of the 1st Division (bombing Schweinfurt) took a terrific shellacking. They lost 35 bombers from their nine groups. The Regensburg boys lost 25, making a total of 60.

"The things that went right with the mission were that we did hit the target, air discipline was good (I don't believe that many of us would have got through that fighter opposition if it wasn't good) and navigation was perfect.

"I think the conclusion which can be drawn from that mission is that without fighter escort all the way to the target and all the way back, heavy bombardment can't operate in daylight against that type of opposition without excessive losses. Look what happened a month or so later, when they sent a second force to Schweinfurt. They lost 60 bombers again, which, added to the 35 they lost on the first mission without destroying the target, makes a total of 95.

"The other conclusion is that heavy bombers cannot be stopped from getting to a target and destroying it. I don't believe we will ever run into greater opposition than we did on the Regensburg mission. Our success there showed that we are training the best damn crews in the world."

Such were the problems, and such was the fighting spirit that prevailed in 1943. Early in 1944 as the 8th Air Force grew stronger, more battle-wise, and as the *Luftwaffe* itself grew weaker, the picture changed. The lesson at Regensburg had been well learned, particularly in regard to fighter escort. First the *Thunderbolts* were equipped with larger tanks, then came the *Lightnings*, and then the *Mustangs*. By January 11, 1944, a 200-mile string of 720 heavy bombers flew over heavily defended territory—300 of them revisited Oschersleben—and fighter escort was provided all the way.

The winter offensive hit its peak in the Big Week of February 19-26. Combined USSTAF-RAF Bomber Command figures for this week are:

Bombers dispatched...	8,148
Fighters dispatched....	4,454
Tons of bombs dropped.	19,177
Bombers lost	400
Fighters lost	39
Enemy fighters lost (in air only).....	642

During this same week the 8th Air Force, joined by the 15th, paid a return call on Regensburg. Since the August attack strenuous repair work had been done and a nearby glider factory at Ober Traubling was converted to Me-109 manufacture. Hit by 613 heavies, both factories were practically wiped out—one of them for the second time.

By now the aircraft complexes were being hammered out of existence. Disperse or die was the order of the day, and disperse they did. The campaign continued until September, 1944. Thereafter it tapered off, with only a few policing missions and a recrudescence of attacks on jet factories in the winter and spring of 1945.

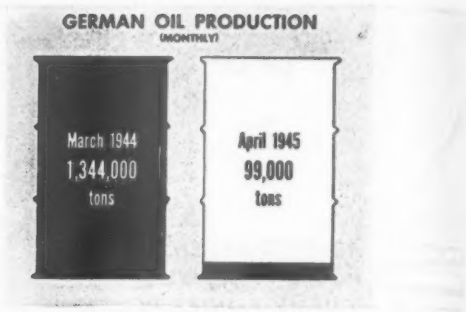
But what had actually happened to aircraft production inside Germany? A few statistics will point up the story.

In the second half of 1943 only 400 tons were dropped monthly by USSTAF on German plants, while in 1944 an average of 6,500 tons a month was dropped. In 1943 58 aircraft plants were damaged as against 146 in 1944. Single-engine fighter aircraft bore the brunt of our attacks. It is estimated that by September 30, 1944, the GAF was deprived of 10,000 news planes which would have been produced.

When we started the campaign in July, 1943, German production of operational types had jumped to about 1,740 monthly, including 910 single-engined fighters. And the GAF planned to produce 3,000 a month late in 1944. But our bombs fell so thick, so fast, so unerringly that the output of combat types only amounted to 1,320 planes in March—less than half of planned production.

From March, 1940, onward, however, the GAF production rose sharply. It reached 1,950 in September, of which 1,400 were single-engined planes. This, of course, reflected the dispersal policy. Production was spread out into countless small plants, including unused textile mills. GAF airfields were used for assembly. Facilities were developed underground. Bomber plants were converted to fighter production.

But all this effort came too late. The reduced output of defensive fighter planes, due to Allied bombing, forced upon the GAF a policy of conservation simply to retain an air force in being. Lack of adequate resistance in turn made possible the successful bombing of Axis industries producing oil, bearings, and other vital war materials. The whole interlocking structure of German industry began to topple, and one disaster seemed automatically to start another.



Modern wars are fought on oil. Our success in bombing German oil was decisive.

The loss of aircraft production at bombed factories—estimated at 10,000 planes between August 1, 1943, and September 30, 1944—was roughly half of the somewhat more than 20,000 lost in combat during the same period. But, in one way or another, the bomber offensive accounted for a large part of these losses. Our bombers and fighters shot down hundreds. Bombing of GAF airfields and repair depots accounted for many more, and lowered serviceability. The remainder of GAF wastage resulted largely from aerial combat with tactical air forces, and strafing and capture of airfields cluttered with immobilized aircraft.

While the dispersed GAF succeeded in increasing its aircraft production despite our campaign, it did not succeed in getting these planes in the air in numbers sufficient to fend off the rapidly growing AAF. The GAF was the victim of superior numbers, better-trained pilots, and the collapse of Germany's industrial system. In its opening campaign USSTAF gave the first big push against industrial Germany's house of cards and, during the process, came of age as the most formidable weapon of modern warfare.

Bombing of Fuel

If, in waging war, you can deny to the enemy something he must have in order to maintain his effort on a scale to match your own, you've got him. It is this simple fact which focused the attention of Allied air leaders on the German liquid fuel industry. Modern nations cannot fight without oil. They cannot even fight with a little oil. They must have it in large quantities, readily available at all times. In a highly integrated war economy, oil was the chink in Germany's armor. Her fuel position was traditionally unsound. For years before the war she imported most of what she used.

Such dependence on foreign sources is naturally unacceptable to a country dedicated to expansion and self-sufficiency. For expansion leads to war, and wars make it difficult for a continental power with a small navy to insure that her imports will not be cut off, particularly since 60 per cent of the crude oil refined in Hamburg came from the United States. Germany's reaction to this situation was twofold.

First, she determined to put to use her large stores of low-grade coal. Coal and oil are closely related atomically. Both are hydrocarbons. Her admittedly superior chemical know-how had already evolved two processes for extracting all kinds of synthetic oils from this coal. These processes (Fischer-Tropsch, and Bergius) are efficient but expensive. With world oil prices as low as they were before the war, only a controlled economy, preparing for war, could have justified their development. All together three major synthetic districts grew up in the neighborhood of three coal deposits, one in the Ruhr, one in Silesia, and one in the Leipzig area.

Germany's second effort to improve her oil position was in the political and military field. When the smoke cleared away from her European conquests, Germany had access to all the oil in Europe. Total theoretical refining capacity in the area

Scholven Buer was one of two synthetic oil plants at Gelsenkirchen in the Ruhr. Between August, 1944, and the end of the war, they were attacked 14 times by the RAF, which dropped 9,445 tons, and 13 times by the 8th Air Force, which dropped 2,855 tons. Both plants were levelled. At Scholven, only the bullet-shaped bomb shelter (left center above) escaped without great damage.

One of the German defenses was to camouflage factories. A fake Skoda works was built about three miles out of Pilsen, and fooled our 15th Air Force once. As the war went on and our photo-interpretation experts developed more experience, camouflage became less effective but there was always the danger of mistaking a fake set for the real thing during the excitement of combat.

she dominated was 27,750,000 metric tons a year. Actual production was much less, due to great excess refining capacity, to the fact that many of the refineries were old-fashioned and unable to produce high-octane fuels in quantity, and to the fact that her newly acquired assets represented somewhat of a hodgepodge. The best refineries were not always located near the richest oil fields. There was a deficiency of pipe lines and rail service in some places. In addition, Germany had to cope with sabotage and a certain number of recalcitrant local plant managers. As a result of all this, actual production in the summer of 1943 amounted to only about 16,500,000 tons a year. Seven million tons were from synthetic plants in Germany. Seven and a half million tons were from crude (nearly two-thirds of it from Ploesti). The balance, amounting to 2,000,000 tons, was made up of substitute fuels such as alcohol, coal tar, aromatics, etc. Production continued at this rate for nearly a year, permitting the Germans to increase their level of stocks from a monthly average of under 3,000,000 tons in 1943 to nearly 4,000,000 tons in April of the following year.

The over-all plan for the oil campaign, which started the following month, called for the destruction of 24 synthetic plants and 80 refineries. The great majority of these were in six districts, the three soft-coal areas mentioned above, the Hamburg-Hanover district, a concentration of refineries in the neighborhood of Vienna, and another at Ploesti. These districts were divided three and three. The 15th Air Force was assigned Silesia, Vienna and Ploesti. The 8th got Hamburg, Leipzig and the Ruhr. Work started immediately. During May, 11 targets were hit, some of them two or three times. In June, 43 attacks were launched. The effect was catastrophic. The German High Command, faced with skyrocketing consumption to combat a large-scale Russian offensive in the East and the Normandy invasion in the West, found their oil production cut almost in half in only two months of attacks. Their reserves, which had looked so generous a few months earlier, were already shrinking dangerously. But this was nothing. By August, production was down to 37 per cent. Three weeks later, Ploesti, which had been nine-tenths destroyed by the 15th Air Force, was captured by the Russians. This freed the bombers of the 15th, who redoubled their efforts against Vienna and Silesia. The RAF was beginning to turn on the heat in increasing force. Production for September shrank to 23 per cent. The enemy, now desperate, was being relentlessly squeezed between the jaws of mounting demand and dwindling supply. There was no fat to draw on. The home front had been living on starvation rations for some time. The *Luftwaffe*, already weakened by the aircraft campaign, was literally dying of thirst. Its training program was shaved to minuscule proportions, all gas being saved for combat operations, and even these became rarer and rarer as the weeks went by.

There were three things the enemy could do. He did them all to the limit of his endurance. First, he spent what little breath there was left in the *Luftwaffe* largely on the protection of oil targets. Second, he could, and did, protect them from the ground with what grew to be the densest concentration of flak the world has ever seen. Last, he could repair the plants. This he did with a doggedness and resourcefulness which is little short of amazing. But, after each attack the job became harder and harder, and the time required longer and longer. Almost every heavy strike destroyed some basic piece of equipment which was impossible to replace. Some plants were reduced by this to the production of only certain types of fuel. Others could be patched up to operate on a reduced scale through bypassing the smashed unit. As time went on, strains and stresses were revealed in units which were at first considered sound after attack. These often broke down by themselves. And whenever it appeared, through photo reconnaissance, that a plant was again in operation, it was again bombed. The sense of frustration created in this way must have been enormous. Captured plant managers have refused to comment on this, but as early as September 17, 1944, it was necessary for Reichsminister of War Production Speer to circulate a sort of "pep talk" telegram which reads partly as follows:

"The idea is spreading that the reconstruction of the synthetic oil plants and refineries is purposeless since the enemy always finds a suitable moment, soon after the resumption of work, to destroy these installations again by air attack. (He then lists some of the plans for dispersing oil production, getting it

underground, etc., and expresses the hope that impending bad weather will give the German oil industry a breather.) It is therefore incorrect to regard reconstruction as a fruitless task; on the contrary, from a long-term point of view, the successful prosecution of the war depends in the final analysis upon this achievement. Heil Hitler!

Yours,

Speer."

Bad weather did come, and the situation was somewhat eased during the fall and early winter. Nevertheless, reserves were generally exhausted and operations of the *Luftwaffe* and *Wehrmacht* were controlled more and more by production and less and less by military necessity. Germany was cracking up. In February the Russians captured the synthetic plants in Silesia. Huge tonnages extinguished the Leipzig and Hamburg plants one after another. The Ruhr was captured. Production skidded to 18½ per cent in March, and to an incredible 7½ per cent in April.

Transportation

Transportation targets are unlike others in that they are both tactical and strategic in nature. Our campaign against the enemy communications system was primarily tactical, but as a byproduct we derived enormous strategic gain from it. This is because only about 25 per cent of the system's capacity was employed to carry military freight, whereas at least 50 per cent was used in the war economy. This means that any reduction in capacity had twice the impact on industrial as on military operations. As a matter of fact, military freight usually carried a top priority, which had the effect of putting almost all the strain of reduced capacity directly on industry.

In addition consider the following peculiarities, all weaknesses, of any rail system: It is a fundamental industry, being essential to all components of the civilian and war economies. It cannot be moved or dispersed. It is so large that it cannot be well defended. It is almost impossible to camouflage effectively. It cannot go underground. Targets are so numerous that there is almost always some part of the system which is not cloud-obscured despite general overcast weather. They are also so varied that they can be attacked by all kinds of aircraft. Heavy attacks within a certain area can be compensated for in part by shifting to road or water transport, but lost capacity cannot be balanced by expansion somewhere else, as is the case in manufacturing. Finally, the effects of air attack are cumulative because the capital investment is exceptionally high and damage cannot be replaced at a rate comparable with the potential rate of new damage. As a result, policing costs are low and enemy recuperation is slow.

Balance these factors against the over-all size, flexibility and initial excess capacity of the enemy system and you have the problem. It was solved by the 8th, 9th and Royal Air Forces, which dropped 400,000 tons on rails in the year March, 1944-April, 1945. The results may be read in the melancholy statements of the German engineers.

Other Industry

At various times during the combined bomber offensive strategic targets other than the Big Three (oil, transportation, aircraft) were hammered by our bombers.

Before 1944 the air forces were not large enogh to go after most of the big target systems. They couldn't penetrate deep into Germany day after day and expect to maintain a bomber force, let alone develop one of any size. Therefore, while they were growing, it was necessary either to hit targets on the fringe of the Nazi empire or else pick out ones which were so concentrated that one or two well-placed blows might have a chance of knocking them out.

The best example of the latter was Schweifurt, where nearly 60 per cent of total Axis anti-friction bearing production was concentrated in three plants. These were attacked on two epic occasions in August and October, 1943. However, serious losses, which amounted to 60 bombers during the October mission, showed that such deep penetrations could not be flown with any regularity until we had licked the escort-fighter problem and could launch them without expectation of such losses. This condition existed in January, 1944, and the really effective dismemberment of German industry by the 8th Air Force can be said to date roughly from this period. This is not to imply that the Schweinfurt attacks were not damaging. They were. So was a similar attack on the Huls rubber plant in July, 1943. They just weren't conclusive. Later, we were big enough to hit—and did hit—armament, textile, ordnance, and many other industries contributing to the German war economy.

Subs, Ships, Docks

During the early part of 1943, when the floor of the Atlantic was being carpeted with Allied supply ships, German submarine construction became top priority for the 8th Air Force. Twelve German U-boat yards were damaged, also the principal bases in northern France. All together in 1943 two-fifths of our tonnage was expended on these targets. The RAF effort, while amounting to only one-fifth of its tonnage for the year, was actually much heavier than our own because of its much greater size at that time. Its area bombing of Hamburg, Emden, Kiel, Wilhelmshaven and Bremen did great damage to all kinds of ship construction and repair.

Because the anti-submarine war at sea proved relatively so much more successful than bombing of construction facilities, U-boats fell off the priority list in the summer of 1943. But the sub menace always remained, and the pens were revisited in 1944 and 1945 by both USAAF and RAF, with a sharp increase in effectiveness in the final attacks due to development of concrete-piercing bombs.

The Cities

The strategic oil campaign may have throttled the German armies, the transportation campaign may have strangled industry, but the area attacks on German cities have changed the face of the nation itself. Almost exclusively the handiwork of the RAF Bomber Command, their sheer weight (430,614 tons in four and one-half years—64,000 of them in the first three months of 1945 alone) has so pulverized the great German population centers that most of them no longer exist except as piles of waste material. The mere job of hauling all this stuff away before reconstruction can begin is something which will occupy the Germans for months—even years.

The pictures shown here and on the following four pages record two kinds of damage. There is the damage done by heavy bombs, the crunching which chews up entire blocks, leaves a few walls standing, burying them up to the second story in debris. The pictures on pages 53 ond 58 are good examples of this. There is also incendiary damage, on a scale which makes the great fire raids on London look like a one-alarm job in the Bushwick section of Brooklyn. Almost every roof and almost every floor of almost every building has fallen into the basement. Notable exceptions are three churches, whose heavy stone vaulting remains.

This is the face of urban Germany today, crushed or gaping, usually both. In either case traffic is stilled, factories destroyed, the labor force as a result left impotent and harmless. The RAF didn't invent area bombing of cities, nor did it start it. But it certainly taught the boys who did start it that they never belonged in the big leagues.

Costs and Problems

The reader has seen pictorially how the Combined Bomber Offensive succeeded in its primary mission of destroying Germany's industry and economic system. He may now inquire what it required of the Allies to accomplish this internal devastation of an enemy nation.

The entire cost to the AAF alone of strategic bombing in Europe, based on Bureau of the Budget estimates, was 27½ billion dollars. No comparable figures are available on the British effort. To operate and maintain the 8th and 15th air forces at their peak strengths involved a combined total of 258,250 officers and enlisted men. No figures can measure the cost in lives lost or the cost in man-hours expended by heroic ground crews who time and again labored the clock around to keep the campaign rolling. Nor can any monetary evaluation be placed on the worth of inventions, notably in the field of electronics, that have been produced under stress of war.

As a starter in analyzing cost of strategic bombing, consider the following breakdown of what an ETO replacement heavy bomber cost the Government from its factory birth to its loss in combat, or its retirement from war weariness. Take a *Liberator* as an example. The airframe costs about $115,300. Props, $4,200. Government equipment (bomb sight, etc.), $50,000. Ordnance, $3,200. Communications, $8,500. Grand total $213,700. To get it into combat, it was necessary for the Ferry-

ing Division of ATC to fly it from the factory across the ocean to England. By the shortest route from the Willow Run *Liberator* plant at Detroit to Prestwick, Scotland, about 23 flying hours are required. On a fuel consumption basis of 210 gallons of 100-130 octaine gasoline per hour, at 23 cents a gallon, this flight will cost $1,100. The life expectancy of an average heavy bomber in ETO was 650-700 flying hours or about 237 days. This necessitated spending another $32,602 for gas alone, not to mention oil or other lubricants. (Statistical Control figures show that one and a quarter *billion* gallons of gasoline were expended by heavy bombers alone during the three and a half years of war with Germany.)

Suppose, in addition, the bomber were so badly hit in combat that it had to go to a depot for repairs. This was no infrequent occurrence: from the beginning of 1944 to April of this year, 61,294 heavies received damage of some sort over Europe. During its combat cycle a bomber averaged 6.7 days in depot repairs, 34.3 days in repair on its own station. Battle damage reports show that at one period in the air war one of every five attacking aircraft was hit by flak. Serious damage was also often caused by empty shell cases, by stray bullets from other friendly bombers, or by self-inflicted machine gun fire. Adding all this up, the estimated cost of major repairs is one quarter of the unit purchase price, or $53,400, for our *Liberator*. No mention has been made yet of engine changes. Under certain operating conditions, as in early dusty days in North Africa, new *Fortress* engines lasted only 15 hours. Even under easier operating conditions, as in the early dusty days in North Africa, combat *Liberator* in its life cycle might easily require eight or more new or rebuilt engines, costing another $60,000.

Over-all cost of the bomber has now reached one-third of a million. Multiply this by the 15,600 heavies that were delivered to ETO and MTO combined and you get five billion-odd dollars or a fifth of the total cost of strategic bombing. To this must be added approximately 18,000 fighter escorts at $83,000 each (the average unit purchase price of a P-38, P-47 and P-51 together), plus cost of the gasoline needed to operate them.

In these computations there has been no consideration of costs of the following items: (a) training, (b) maintenance, (c) air base construction, (d) aviation research, (e) subsistence of military and civilian personnel, (f) transportation, (g) clothing and equippage, (h) medical supplies, (i) pay and allowances, (j) chemical warfare, (k) ammunition and bombs. Obviously this list can be greatly expanded.

When a final cost analysis is made, it will show that the 27 billion dollar price paid by the United States for the strategic bombing campaign in Europe was only an approximate 11 per cent of our over-all war expenses up to December 31, 1944. Of all the war's varied and titanic investments, there was surely no sounder one than this, if war investments can ever be calculated on a simple dollars-and-cents basis. One fact stands out: strategic air power cost the enemy far more than it did us.

Not only did it require tremendous expenditures to mount the strategic bombardment campaign, but it was also necessary to overcome numerous operational difficulties peculiar to the European and Mediterranean theaters. One report aptly sums up the case: "As usual we can start out by stating that unsuitable weather limited air operations."

Maintenance of heavy bombers in Europe encountered the following main weather problems: mud, rain, frost, low temperatures in flight and icing. Thanks to the excellent lend-lease-constructed airdromes in England, mud did not present such a problem as it did in Italy. There, during frequent rainy spells, planes bogged down whenever they happened to leave reinforced surfaces. It likewise was impossible to prevent battle-damaged planes from over-shooting runways onto soft ground. Another disrupting factor was mud being tracked into aircraft by crew members, which sometimes worked down into cable pulleys, fairleads, guides, electrical terminals or connectors, causing failures of equipment. It was a particular nuisance in maintenance of escort fighters, where it collected in landing gear, blotted out gun cameras and in general made conditions hell to work in.

Precipitation in the form of rain or snow had slight effect on air operations themselves, but it frequently made ground crew activities well nigh impossible. Frost during winter was also troublesome, because, as any flyer knows, planes are unsafe to fly until it is eliminated. This problem was satisfactorily solved by application of a special liquid which melts frost and retards further accumulation. Low flight temperatures had their greatest effect on personnel, notably waist and tail gunners who were often exposed to temperatures of 55° below over Germany in winter. Icing was a particular deterrent to operations. At one point in January of this year the 15th Air Force was grounded 10 consecutive days because of icing conditions either at base or en route to targets. Included in the figure of over 9,000 heavy bombers lost in ETO and MTO are 1,097 destroyed for reasons "other than combat." A great number of these can be attributed to adverse weather.

Difficult as were heavy bomber missions during spells of bad weather, it was even tougher for the escort fighter. In the first place, instrument flying depends largely on the airplane simulating a steady platform. The larger the plane, the less effect turbulence has on it. A pursuit not only is light, but it also has highly sensitive controls to permit greater maneuverability in combat. Rough air or slight errors in flying technique, virtually unnoticeable in a *Fortress*, are exaggerated in a fighter, may cause it to assume dangerous attitudes. Perfect trim, so important in good instrument flying, is also hard to achieve in a single-engined plane because of torque.

Nevertheless, frequently the "little friends" went out on escort duty when the ceiling was only 600 feet and visibility a mile and a half. Cloud layers sometimes piled up to 28,000 feet; despite this, missions were scheduled and carried out. Instead of having a method of assembly on homing beacons, fighters formed their flights of four below the overcast and, as soon as they were assembled, the leader would start a straight-away climb up into the soup. The three wing men would nestle up close like a flock of ducks and concentrate entirely on flying tight formation while the leader did the instrument flying. Not infrequently visibility became so bad that unless they virtually overlapped wings they would lose sight of their flight commander. This one man had to take responsibility for three others but our pilots were entirely up to the job. Unfortunately, on some occasions inexperinced wing men, flying their first combat missions, would become confused after long, tiring stretches of weather flying. It wasn't difficult to think that the flight leader was turning when he really wasn't. Thus, the wing man sometimes would start to turn, find himself in a cockeyed attitude, get vertigo, lose his position and reference on his lead and finally go into a spin. Several pilots were lost in this fashion.

On some occasions planes got back to their home bases only to find them socked in by the impenetrable English ground fog. It was still possible to get them down safely by routing them to airdromes equipped with the ingenious British FIDO (Fog, Intensive, Dispersal Of) method, which employed gasoline burners along the runways. These warmed the air sufficiently to cause condensation of fog in the immediate area, rising visibility so that planes could land safely. By this device heavy bombers were able to operate against von Rundstedt's supply lines during the Battle of the Bulge.

The problem of unexpected bad weather en route to target sometimes caused missions to abort. To obviate this, a new role was designed for the already invaluable 8th Air Force escort fighter. A Scouting Force was established to act as a "seeing eye" for the heavies. The advance unit consisted of a flight of fighters manned by experienced bombardment pilots who had been retrained on single-engined planes. These men, many of whom had completed their tour of duty, preceded bomber formations, investigated weather conditions and advised wing or division commanders by VHF of the best possible courses to take. They also rendered invaluable assistance to large formations, attempting assembly during hampering cloud conditions. Here is the attitude of one 8th Air Force group CO on their value:

"Time and again the Scouting Force was able to make the necessary exploration in advance and relay the vital information needed. Many times it has suggested changes in course and altitude which brought the formation around weather obstructions or through safe channels. On some occasions information that an apparently impenetrable cloud formation was actually 'thin' enough to be safely penetrated has been promptly forwarded by Scouting Force units."

By the war's end almost all operational problems had been overcome except that of German flak. END

WHY WERE THEY BEATEN?

Dr. Hjalmar Horace Greeley Schacht, former German finance minister: "Germany lost the war the day it started. Your bombers destroyed German production, and Allied production made the defeat of Germany certain."

Generalleutnant Adolf Galland, Chief of Fighters, GAF: "In my opinion, it was the Allied bombing of our oil industries that had the greatest effect on the German war potential. Even our supplies for training new airmen were severely curtailed—we had plenty of planes from the autumn of 1944 on, and there were enough pilots up to the end of that year, but lack of petrol didn't permit the expansion of proper training to the air force as a whole.

"In the African campaign and in Sicily and Italy, Allied successes were largely due to Allied air superiority. In my opinion, strategic bombing never forced any great change in German strategy and planning until after the opening of the invasion. Then, disorganization of German communications in the west by strategic bombing caused withdrawal to the German frontier. In the last two months of the war, the crippling of the German transport system brought about the final callapse."

General Jahn, Commander in Lombardy: "The attacks on the German transport system, co-ordinated with the serious losses in the fuel industry, had a paralyzing effect not only on the industries attacked but on all other industries as well."

Generaloberst Heinz Guderian, former Chief of Staff, German ground forces, and Inspector General of armored units: "Lack of German air superiority in Normandy led to complete breakdown of German net of communications. The German Air Force was unable to cope with Allied air superiority in the West."

General der Infanterie Georg Thomas, military chief of the German office of Production: "Bombing alone could not have beaten Germany, but without bombing the war would have lasted for years longer."

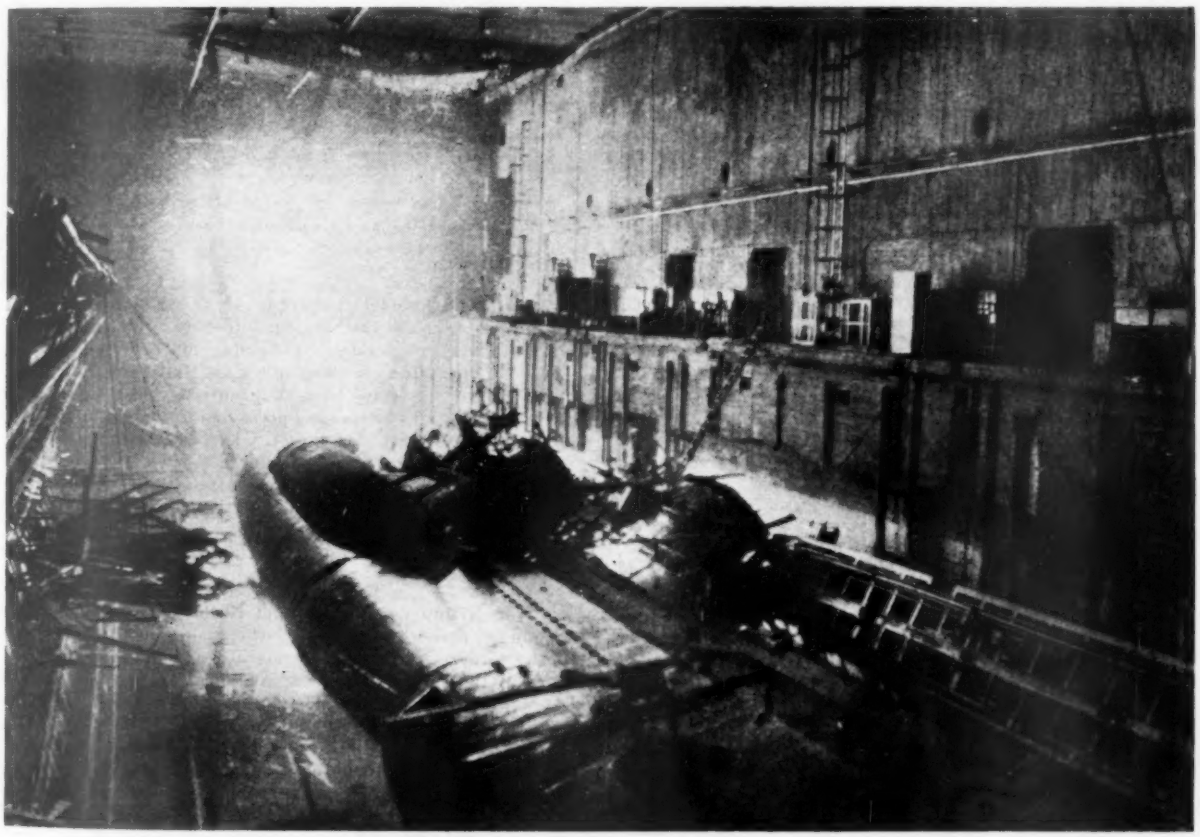
General der Flieger Hans-Georg von Seidel, Commander-in-Chief, Luftflotte 10: "I had no first-hand experience in the matter, but it is my opinion that without disruption of German communications, the invasion would have been a failure.

"The decisive factor in the German defeat was the disruption of German transport communications by Allied air power."

General Feldmarschall Albert Kesselring, Commander-in-Chief in the West, succeeding von Rundstedt, and formerly Commander-in-Chief in Italy: "Dive-bombing and terror attacks on civilians, combined with the heavy bombing, proved our undoing.

"Allied air power was the greatest single reason for the German defeat."

Generaloberst von Vietinghoff, Supreme Commander in Southwest (Italy): "Insofar as it is possible to judge from Italy, it is generally recognized that Allied air attacks (on the aircraft and fuel industries) were extremely successful. This is especially true with reference to attacks on the fuel



When Nazi submarines were sinking hundreds of thousands of tons of Allied shipping and threatening the whole course of the war, the German U-boat construction yards became top priority for Allied bombers. Here two subs are shown smashed by an RAF bomb that punctured a 12-foot-thick reinforced concrete roof. U-boats fell off priority lists after anti-sub war was more successful.

The ruined cities bespeak an awesome devastation that sometimes seems enough to have driven any people to its knees. Yet all evidence suggests that it was not the promiscuous destruction of cities but the coldly calculated bombing of specific industrial targets—oil refineries, transportation, factories—that won the war by destroying the enemy's ability to fight on.

industry, which by the end of the war proved to be the decisive factor."

Oscar Henschel, leading German industrialist, sole builder of Tiger Tanks: "Bombing caused our production figures to drop considerably. The Henschel factories produced only 42 Tiger Tanks (Tiger Royal) in February 1945 instead of the 120 they had been ordered to build.

"Allied attacks of September, 1944, were the most effective, I believe. If the bombers had kept up their attacks on my plants for two or three successive days, they would have been put out of commission for months."

The director of Germany's steel combine: "If you had started bombing a year later, the Westwall would never have been pierced.

"The virtual flattening of the great steel city of Dusseldorf, Germany's Pittsburgh, contributed at least 50 percent of the collapse of the German war effort."

The general manager of Junkers in Italy: "The attacks on the ball-bearing industry were an unqualified success and disorganized Germany's entire war production. I am surprised, however, that such attacks did not come earlier, when Germany's whole output was centered in two centers, Schweinfurt and Friedrichshaven.

"The Allied attacks on German lines of communication were even more effective than the bombing of factories. Railway traffic was worst hit as, due to the increasing shortage of petrol, the roads were being less used."

Christian Schneider, manager of Leuna Works, one of Germany's largest synthetic gasoline and oil plants: "Up until a week ago (middle of April 1945), the Leuna plant was still operating, turning out a pitifully thin trickle of fuel. The output was so small compared with its capacity potential that production officials had difficulty plotting it on a chart. The 8th Air Force twice knocked out the plant so that the production was nil for a period of 15 days, and once the RAF did the same. Once after the attacks started, the plant got back to 70 per cent capacity production for a period of 10 days. Another attack, and the plant got back to 50 per cent. But from then on it never got more than a mere drop in comparison to its capacity."

Alfred Krupp von Bohlen und Halbach, leading German armament maker: "Allied air attacks left only 40 per cent of the Krupp works able to operate now. These plants of mine, and German industry as a whole, were more hampered by lack of speedy and adequate transportation facilities since the beginning of 1943, than by anything else.

"The Allies, from their point of view, made a great mistake in failing to bomb rail lines and canals much earlier. Transport was the greatest bottleneck in production. Plants can and were dispersed, but the Reichsbahn couldn't put its lines underground."

Another special section, on tactical bombing, paralleling this report on strategic bombing, will appear in next month's issue of FLYING.

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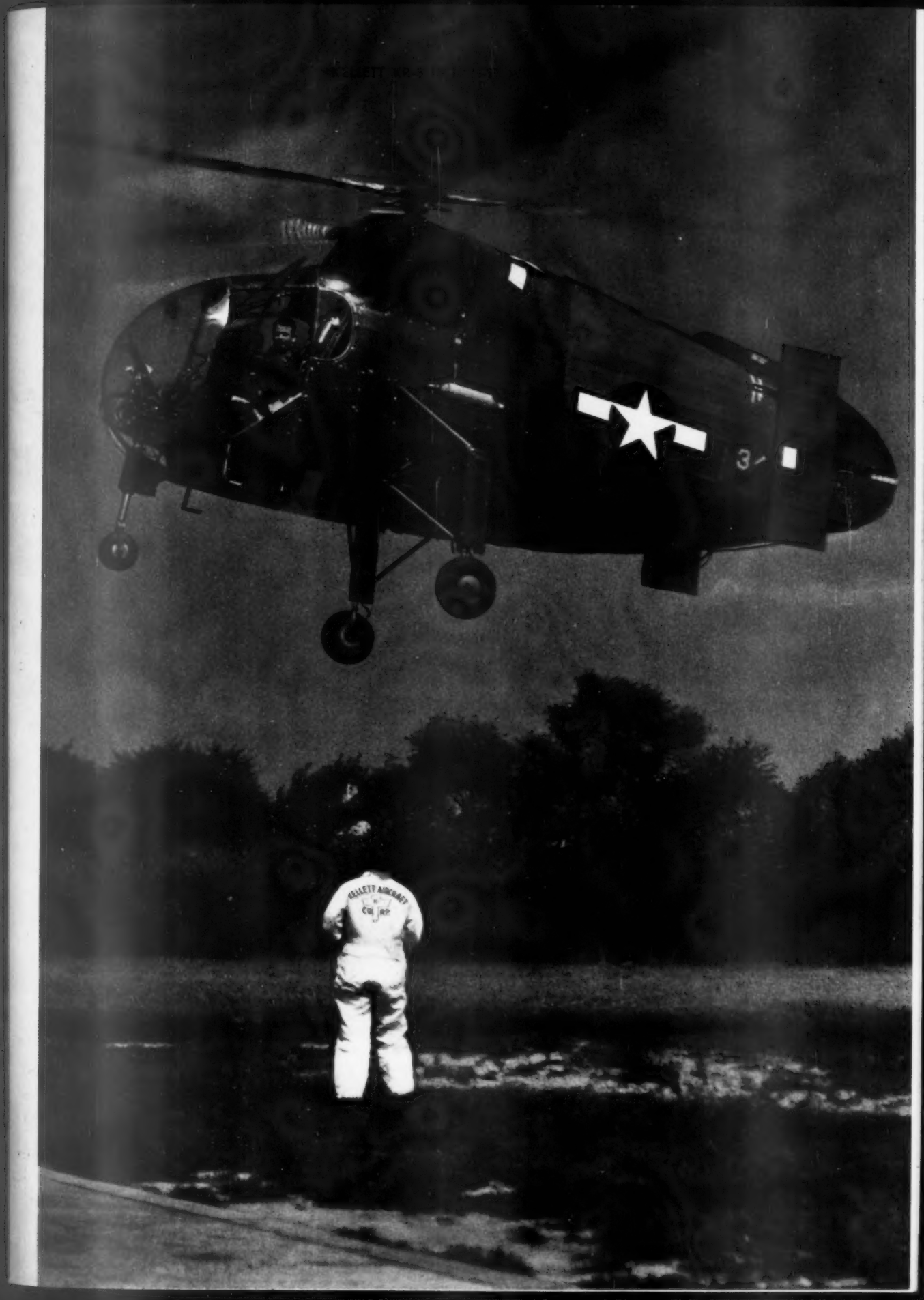
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CLOTHESLINE AIR STRIP

By KEN DAVIS

The flying trapeze comes to life — take offs and landings on a 500-foot cable 65 feet in the air.

Brodie take-off: right to left, as pilot guns engine, ground crewmen trips travel release. Plane begins trolley take-off run. Pilot releases hook from trolley, becomes airborne.

IN the prize fight game to have "pulled a Brodie" means a fighter deliberately lost a fight. But in the flight game, the term is applied to a flyer who lands or takes off in his lightplane from a slender steel cable suspended 60 feet in the air.

Bizarre as it may seem, pilots of the Army Air Forces do just that, over land or ships at sea. Flying lightplanes equipped with a lightweight overhead hook, they snag a sling hung from the cable and roll to a braked halt like a giant department store change basket. To take off, they change slings, "rev" the engine and, at flying speed, they pull a lanyard which frees the plane from the sling.

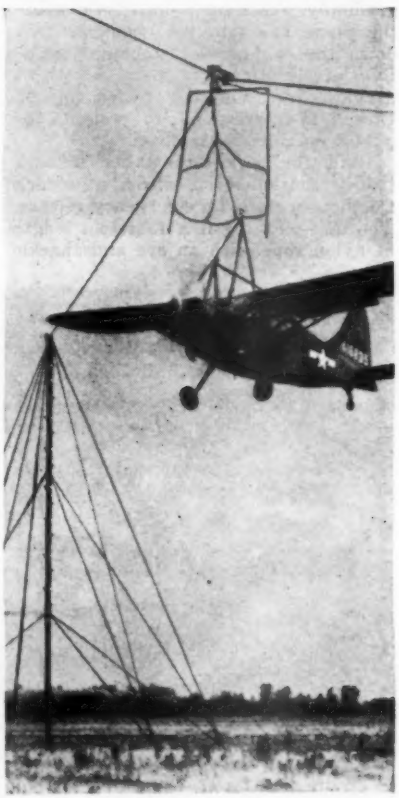
The Brodie system—named for Capt. James H. Brodie, of the AAF Transportation Corps, who dreamed up the idea during the dark days of the Battle of the Atlantic—is no circus stunt. Hundreds of successful landings and take-offs have rubbed the big top flavor from a project which months ago sounded like the prognostications of a pulp fiction writer.

"Many of the pilots who have used the Brodie system would rather land or take off from the cable than to use the conventional method of letting down on the ground, "explains 23-year old F/O Raymond Gregory of Cleveland, O., the first regularly assigned Brodie-system test pilot. "I've made more than 300 landings and take-offs on the wire, and I know I like it best."

This is a mental attitude attained only by experience, however. So utterly foreign to normal procedure is the system that Captain Brodie had a great deal of difficulty obtaining test pilots for the first rig. Transient AAF pilots temporarily stationed at New Orleans, where the rig first was constructed, would volunteer for the assignment—sight unseen. But after looking at the slender wire upon which their plane would land they found innumerable excuses for not making a test landing or take-off.

Like a Paul Bunyan clothes line, the tight, overhead cableway of the portable ground rig stretches between 65-foot tubular steel masts, two at each end of the wire. V-shaped bridle cables connect the masts and the main cable, leaving both ends open to approach.

The landing trolley, with a single light wheel, is designed to give a pendulum effect upon acceleration, reduc-



Brodie landing: pilot of L-5 about to snag nylon landing sling loop with plane's hook.

Capt. James H. Brodie (right), Brodie system inventor, and F/O Raymond Gregory, pilot, whose combined efforts developed this unique take-off and landing system.

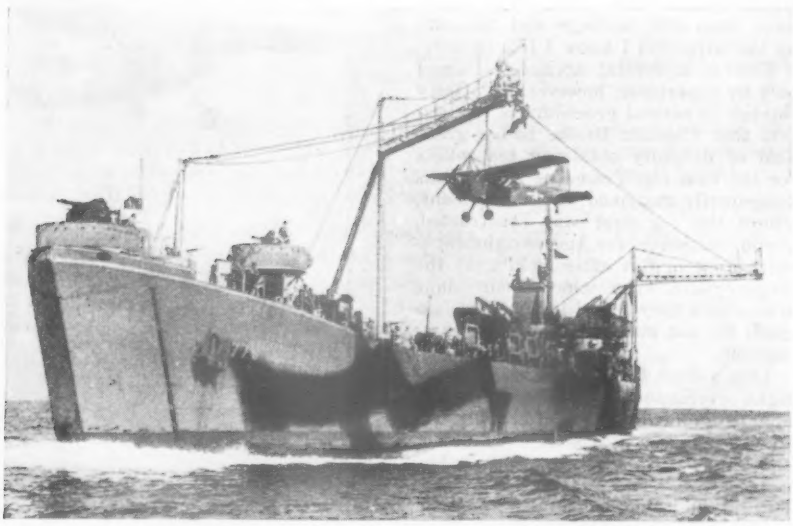
ing inertia forces. To the landing trolley is shackled the landing sling—three loops of nylon rope affording a six-foot target to incoming planes. Engagement of just one of the loops is sufficient for a successful landing.

An arresting brake resists flying momentum on the principle of a giant fishing reel. Brake force is applied gradually, reaching a maximum after the plane has traveled about 50 feet down the cableway—a constant negative acceleration of about one-third gravity. Arresting line tension may be varied to correspond to weights of planes making the landing.

Built for easy rolling, the take-off trolley consists of a wheel, a wooden friction shoe and an emergency release. The take-off sling is a four-foot length of nylon rope with an eye and shackle at the top, a round lifting ring in the middle and a bottom stirrup. The plane hook is put into the stirrup, a lifting derrick carries the plane upward by the middle ring and the top shackle is attached to the trolley.

A travel release, consisting of a long hold-back line and a spring-loaded trip, prevents the plane from beginning its run until the engine is sufficiently "revved" up. A pull on the light lanyard attached to the trip lever disconnects the plane from the hold-back and allows it to begin its take-off run. An emergency release functons if the plane has not been released from the take-off sling and trolley before the end of the cableway is reached on the take-off run.

Without wind, the average lightplane take off from the cable in 400 feet. With wind, it can get off in 200 feet.



Brodie system was successfully used by Navy during war. Above, an L-5 engages the take-off sling. Cable is suspended by outboard booms on ship's port side.

Granting that the Brodie system is an engineering coup, an aeronautical curiosity, the uninitiate still is inclined to ask: What is its worth? What does the system offer in practical military or commercial value?

Grasshoppers—light liaison planes—compiled an enviable record in the war just past, as media for messenger service, observation and direction of artillery fire and patrol against submarines. Though comparatively slow, light and unarmed, these craft definitely are a part of modern war. But they are short of range, and anything which might lengthen the time they can spend in the air, or which can provide a means of getting the plane on the scene at all, is extremely valuable.

Independent of terrain, the Brodie rig provides a good landing and take-off site in the most unlikely country—jungles, mountains, marshes, deserts; in fact, any place where construction of a conventional runway or landing strip is difficult or uneconomical. Moreover, it is adaptable to forward military positions due to the ease with which it can be camouflaged. From above 500 feet, the Brodie system is extremely difficult to see at all, and even if the enemy spots it the rig structurally is an elusive target.

Weighing less than 7,000 pounds, including tools and tackle, the rig is highly portable. Its components are small and light enough to be carried in cargo planes, along with a nine-man crew, and parachuted into a designated position. Where roads exist, one five-ton or two 2 1/2-ton trucks are sufficient to haul the crew and all equipment. With the use of hand-operated tools and tackle, the rig can be made ready for landings and take-offs in little more than 12 hours. At sea the 300-foot long cable is supported by booms, kingposts and bracing struts, elevated and outboard parallel and on the port side of the ship.

Its actual participation in the war in the Pacific, for which it is ideally suited, still is shrouded in War Department secrecy. Apparently the results of its use at Iwo or Okinawa—or whatever far battlefield saw use of the Brodie system—were satisfactory.

Commercially, the future of the system is every bit as flamboyant in possibilities as was its wartime use.

"Right now," Brodie declared in discussing cargo possibilities, "we could build a rig capable of handling planes much heavier than L-5's. We could handle up to 6,500 or 7,000-pound airplanes."

He forsees light cargo routes utilizing Brodie rigs to reduce the amount of gasoline necessary to propel the planes between landings. By decreasing the gas load, the planes could increase the pay load proportionately.

Rubber plantation supervisors could use the Brodie system for visiting obscure sections. Canada may prove a fertile ground for selling the system,

(*Continued on page* **119**)

He Makes a Flying Visit Every Week

"To a traveling salesman, the Aeronca idea is a gift from Heaven! I find airstrips or airparks wherever I want to go, even in small towns. I can call on my customers every week now, instead of every two or three—and fly home weekends to be with my family!"

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Speaking of the planes themselves, an Aeronca will mean not one type of plane for everybody, but a model for everyone's needs—a complete line from 2-passenger to family capacity, all easy to buy and easy to fly. "Aeronca—the Plane You'll Want to Fly" describes them all.

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War experience has proved American-made planes outstanding in many respects, but it is in ruggedness that our aircraft lead the world. Near the top for toughness among U.S. ships is the little-known J2F-6, Columbia Aircraft's aptly-named "Durable Duck."

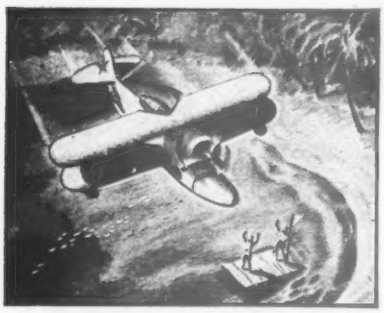
Employed for scouting, reconnaissance, photographic observation, plasma delivery, rescue work, and numerous other chores, the Duck is ship-of-all-work. Because it is versatile, durable, and able to land and take off where more glamorous planes can't, it is in rescue work that the Duck wins its laurels.

70 Yards for Landing

One Duck landed in smashing seas,

taxied nine miles with waves breaking over its top wing, then took off without a sputter. Another landed in a reef-rimmed 70-yard inlet, took off cross-wind inside 200 feet, despite a severe pounding.

Best example of Duck durability is the J2F-6 that was being towed by a



surface ship in high seas. The tow-line parted twice, waves filled the cockpit, submerging the plane's lower wing. Further towing was impossible, so the Duck was abandoned.

Next day the Duck was still afloat, had to be sunk by shells from a warship—two hits were required to make it go down!

Snatching Wounded from Japs

Ducks have sidled in to "impossible" landings in Jap territory, while escort fighters circled overhead. Often, the Duck took the air again with a full load of wounded, sometimes with an overload lashed to the wings.

No thing of beauty on the ground, the amphibious Duck becomes oddly impressive in flight. Over both oceans, it has functioned effectively as a scout plane, mercy ship and dependable beast of burden.

It was a Duck that found the Nazi weather station in Greenland. Another Duck, operating out of Henderson Field, Guadalcanal, picked no less than twenty downed pilots from the sea.

For its many rescues, word came from the Pacific that the ungainly but rugged amphibian had earned a new nickname, "The Beloved Duck."

Justly proud of the gallant performance of the Duck, Columbia Aircraft workers are now engaged, under Navy supervision, in building a new amphibian—larger, with increased range and greater load capacity. The same men and women who built the sturdy Duck are building the new and even more versatile plane. And the same craftsmanship which has made the Duck a by-word for ruggedness and reliability will distinguish Columbia's new workhorse of the air. Columbia Aircraft Corporation, Valley Stream, N. Y.

The Outlook for Aviation

(Continued from page 28)

in metropolitan areas. A total of 6,305 airports would be available on completion of the program.

Parallel expansion of all CAA activities is proposed in the report. Federal airways would be rebuilt at a cost of $20,000,000. Included in the plans is conversion of the 291 radio range stations in the United States to very high frequencies, establishment of 24 new-type stations for long-range direction finding, installation at all major airports of instrument landing systems, and speeding up of traffic control procedures with automatic equipment.

Aviation education in foreign fields should, the plan proposes, be continued and expanded by training foreign nationals, by technical civil aviation missions to foreign countries, by similar missions from abroad, and by translation and distribution of selected American technical publications.

"For an annual expenditure of less than our cost of waging war for half a day," the report argues, "aviation would become an industry providing basic employment to at least 630,000 people, as compared with only 99,000 in 1939. Revenue of the industry in 1955 would approximate $3,000,000,000, or nearly four times the 1939 total."

"The time for post-war 'planning' has run out. Post-war action is required," the program proposed.

"No other industry now in sight offers hope of so much response to so little stimulus from the Federal Government. Neither business alone, nor Government alone, can assure the continued economic well-being of our country. Their combined efforts, with private enterprise playing the major role and government aiding as required, can bring us to a new frontier of prosperity."

The analysis ends on a typical Henry Wallace note:

"Aviation is only one phase of the problem, but what we do to salvage this war-spawned giant is in a sense a test of our ability to grasp and make real the tremendous potentialities of our whole post-war economy. Government management, and labor working together built this $20,000,000,000 war industry. With equal foresight and cooperation, civil aviation can pioneer to a new economic frontier."

"Civil Aviation and the National Economy" was prepared by the CAA Office of Aviation Information under the direction of Ben Stern, assistant CAA Administrator. Text was written by Raymond Nathan, statistics compiled by Stafford Kernan, Jesse Sternberger, Ruth Haken, and Hugh May, and pictographs by staff artists. All personnel is in the Aviation Information Office.

Originally only 500 copies were printed, but a new printing of 5,000 had been ordered as this goes to press and is available at 5 cents a copy through FLYING'S Washington office, 1319 F Street, N.W., Washington 4, D.C. END

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MODEL 117

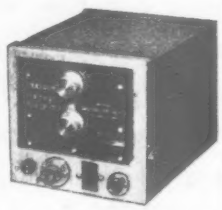
The "117" is a dry-battery-operated 5-tube superheterodyne receiver of an entirely new design that offers performance never before possible in such a small aircraft radio. Mounts in 3" instrument panel opening. Specifications: Range, 195-410KC; Receiver size, 3 3/4" cube, weight, 1 lb. 12 ozs; Battery pack size, 2 3/4" x 2 3/4" x 6 1/2", weight, 2 lbs. 2 ozs.

MODEL 116

The "116" is a five-tube superheterodyne receiver providing selectivity and sensitivity of an extremely high order; it is powered by the Model 209 Transmitter. It serves as the remote-control for the "209" The "116" mounts on the instrument panel in a standard 3" opening. Specifications: Range, 195-410 KC; size, 4" x 4" x 6 1/2", weight, 2 lbs. 8 ozs.

MODEL 209

The "209" is a 12-volt transmitter of over 35 watts output. It gives trailing-wire performance with a fixed antenna. It is completely controlled through the "116" receiver. Dimensions: 7¼" x 7" x 9" The Model 116 and Model 209 combination weighs less than 16 pounds completely installed.



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REPORT FROM WASHINGTON

RUMORS have long been rife concerning who is to fill the 15 month old vacancy on the Civil Aeronautics Board resulting from Edward P. Warner's resignation. Charles I. Stanton, deputy CAA administrator led the field of candidates early in the summer—then his star faded and it was anybody's job. Lieut. Gen. Jimmy Doolittle was seriously considered for the job. Nearly a score of other candidates made their bid as time went by. After a bit of sifting, here are the facts that can be winnowed: Stanton was the Board's choice for the post when it became known that Warner was leaving. The Board wanted a man schooled in the technical aspects of aviation, and Stanton seemed to be the ideal choice. With the approval of top men in both and CAA and CAB, Chairman Welch Pogue took the nomination to the White House. The aviation industry was watching from the sidelines, was flattered by the importance given an aviation post by the new administration. At the same time, the industry was perturbed by the unmistakable evidence that politicos could wield a big stick when the choice of a new board member was in question.

Flying Response

An article entitled "Your Own Airport!" in the September, 1945, issue of FLYING apparently was just what hundreds of men in uniform and ex-service men recently discharged had been wanting. The response was immediate and—to the CAA Office of Information and Statistics—somewhat bewildering. Telephone calls and letters began to pour into CAA within a week after the magazine was distributed and, although the volume has diminished, they are still being received daily. In almost every case the caller or correspondent requested copies of one or more of 12 pamphlets listed in a box accompanying the article. The pamphlets contain specific information for those contemplating construction of a flight strip or an airport at the edge of town. The Aircraft Industries Association, sponsor of one of the pamphlets, also received numerous requests from persons who had read the article.

The article contained one error, but it merely served to bring about a needed change in CAA policy. The article listed the Government Printing Office prices of certain pamphlets and added the notation that "CAA in most cases would provide the pamphlets free to servicemen." Until that was published, CAA had been sending the pamphlets free to servicemen overseas and referring uniformed men in the U.S. to the printing office. The error corrected that situation; all servicemen are now getting the pamphlets without charge.

Docket No. 1501

Oral argument on the CAB examiners' recommendation that certain restrictions be placed on non-scheduled air services will bring forth a storm of protest from organizations representing non-certified air operations and private aviation. The opposition will be led by the United Pilots and Mechanics Association, CAA Non-Scheduled Advisory Committee, Aircraft Owners and Pilots Association, Aeronautical Training Society, and National Aviation Trades Association. These groups will be supported by several state aeronautic commissions, individuals conducting air charter service, and the transportation department of the U.S. Chamber of Commerce.

T. P. Wright, administrator of CAA, has filed with CAB the following letter on behalf of the advisory committee: "The CAA Non-Scheduled Advisory Committee believes that charter operations should be permitted unrestricted operating privileges until complete data (on the scope of operations) is developed. Previous experience being entirely inadequate for the basis of any regulation, paragraph C, Appendix 3, of Docket 1501 (limiting fixed base air carriers to a maximum of 10 trips a month between designated bases) should be deleted, for such proposed regulation would constitute a disservice to the public desiring air taxi facilities."

James W. Batchelor, counsel to the United Pilots and Mechanics Association, filed a two-page comment which contains the following statements: "The evidence submitted and the examiners' findings establish the fact that no need exists for repeal of the existing order exempting non-scheduled air carriers from provisions of the Civil Aeronautics Act. The record establishes that non-scheduled or charter operations have been so limited in extent and volume that such services have not had, nor can they have in the immediate future, any appreciable economic effect on existing certificated carriers. From a legal standpoint the proposed order would merely confine existing non-scheduled operations within state lines and prohibit the carriage of anything but intrastate business. The practical effect would be to give added impetus to the movement of many state governments to invade the air carrier regulation field on a state basis, thus adding further duplicity and confusion to at-

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The Stratocruiser brings a new, unprecedented standard of performance, operating efficiency and reliability. For it makes full use of the aerodynamic, structural and mechanical advancements developed by Boeing for big bombers and transports during the war. It has a maximum cruising speed of 340 miles per hour and provides exceptionally low operating costs over a wide range of flying distances —from 300 to more than 3000 miles.

Most versatile of all large aircraft, its spacious double-deck design and big payload capacity fit the Stratocruiser for almost every type of medium or long range operation. In the standard, domestic version, 81 passengers may be carried—67 on the upper deck in large, comfortable reclining chairs and 14 in luxurious seats in the lounge—with ample luggage and cargo capacity. As a de luxe transocean plane, the Stratocruiser will accommodate 75 passengers on daylight trips or at night —provide 30 unusually spacious berths plus 15 additional seats—together with baggage and cargo. As a "commuter" transport, it can seat 114 passengers, and in all-cargo operation its 19½-ton capacity and easy-loading provisions make it outstandingly efficient.

For any of these kinds of service, the Boeing Stratocruiser offers the lowest direct operating cost per ton mile achieved by any existing aircraft. To meet the need for all types of feeder and main line operation, other Boeing transports are also on the way.

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The extraordinary performance of the Stratocruiser stems directly from Boeing principles of research, design, engineering and manufacture. You can be sure that any airplane "Built by Boeing" is built to lead.

DESIGNERS OF THE B-29 SUPERFORTRESS • THE FLYING FORTRESS • THE NEW STRATOCRUISER
THE KAYDET TRAINER • THE STRATOLINER • PAN AMERICAN CLIPPERS

BOEING

tempts at orderly development of the non-scheduled phase of the air transportation."

The AOPA submitted this report to the CAB: "Comments received by this organization with regard to revision or elimination of general exemption order 212.1 of the economic regulation definitely indicate such action would constitute a serious drawback to the growth of private airport operation and non-scheduled aviation."

The Air Transport Association and several of its members—notably TWA United and American—will spearhead the group favoring economic regulation of non-scheduled air carriers.

Northrop Experiments

LaMotte Cohu, vice-president and general manager of Northrop Aircraft Inc., has disclosed that his company is working on new power plants of its own design, both gas turbines and jet units. Details are company and military secrets, but the power plants are in the test stage of development and it is reasonable to assume that they will be used in future Northrop planes. Cohu believes that Army and Navy planes now flying, including the *Shooting Star*, are obsolete; that belief is based on the performance of planes now under test at Muroc Lake and on anticipated performance of those now in the design or mock-up stage. Northrop, far ahead of many other companies in research, has been selected as one of the major peacetime military aircraft manufacturers. One new Northrop plane which has lived up to design expectations is scheduled to reach full production in January.

AAF Casualties

Slightly more than one-third of the total casualties in the AAF during the war were recorded in the continental U.S. Casualties outside the U.S. to V-J day were 73,700 and the number if the country in the same period reached 25,700. Continental casualties to V-E day were: dead, 13,800; injured, 10,600; total 24,400. In the foreign theaters casualties to V-E day were: dead, 36,500; missing, 16,600; wounded, 17,800; total, 70,900.

Dimensional Units

With U.S. policy on international standardization of dimensional units used in air navigation in mind, the CAB is circulating for opinion the following three questions: (1) Should the meter be substituted for the foot as a normal unit of measurement of altitude, as used in the graduation of altimeters, in the issuance of traffic clearances and instructions, and in giving meteorological information? (2) Should the statute mile be replaced either by the nautical mile or by the kilometer in measuring distance and speed, including wind speed? (3) Should the kilogram be substituted for the pound in giving airplane weights and load limits?

The results of the survey will be aired in discussions of dimensional standardization during the Provisional International Civil Organization sessions in Montreal.

The British Royal Air Force recently abandoned the statute mile in favor of the nautical mile in all air operation, including the measurement of air speed. CAB in explanatory material accompanying the three questions points out that the nautical mile may continue to be used by navigators while another unit is employed for other persons, since the relation between the kilometer and the nautical mile has some advantage over that between the nautical mile and the statute mile. The kilometer is approximately half a nautical mile, so that a simple 2 to 1 ratio can be used for rough approximation, while the correction factor from the statute mile to the nautical mile is more than 15 per cent.

Republic Transport

Republic Aviation, latest aircraft manufacturer to move into the transport field, is reported to have received an order for one commercial version of its four-engined military plane. The plane would be used in international operations, probably by a U.S. carrier. Orders for the *Seabee* continue to mount and Republic has finally settled on a price for the four-place amphibian. It is $3,950. Two-way radio will be standard equipment in the Seabee and will not be an extra cost item. END

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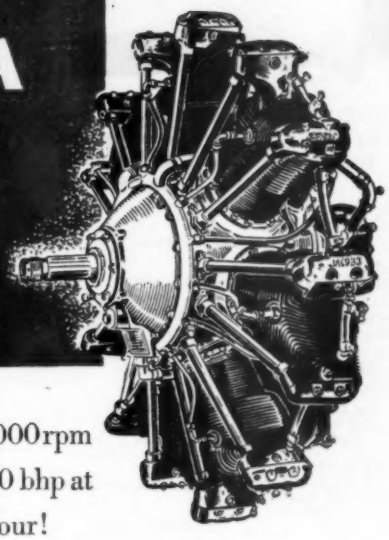

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SPECIFICATIONS

TYPE—Direct drive, seven cylinder, air-cooled radial
TAKE-OFF Rating—300 bhp at 2200 rpm
NORMAL Rating—300 bhp at 2200 rpm (at sea level, on 80 octane fuel)
DRY WEIGHT—505 lbs., without accessories
BORE—5.25 inches
STROKE—5.00 inches
DISPLACEMENT—757 cubic inches
COMPRESSION RATIO—6.0 to 1
IGNITION—Magneto-battery, radio-shielded
OVERALL LENGTH—39.5 inches
DIAMETER—44.0 inches

JACOBS · **Pottstown, Pa.**
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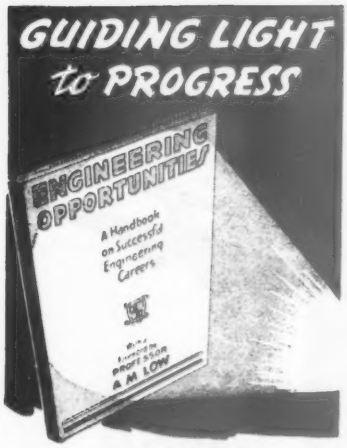

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Airports for Everybody

(Continued from page 29)

the transfer of title depending on the location of the field. Local communities thus gaining title to a field will have sole control of it and may, if they desire, make leasing arrangements with private operators, always providing they are used to forward aviation progress and are available in case of national emergency.

During a national emergency, the Government will share costs on any facilities it shares and pay rent on any that it takes over. The bill also specifies that the Government, during the first five years after the field is turned over, shall make up any deficits incurred in maintaining the field. This assures the community operation without loss.

If, at the end of five years, the Government wants to withdraw maintenance funds, the community holding a title will return it to the Federal Government, which will dispose of the facilities under the regular Surplus Property Act rules. Federal disposal of the property, both now and in the future, will be in the hands of the Surplus Property Board—but always subject to the regulations of the Surplus Airport Act.

The maintenance clause shall also apply to CAA-financed airports now in operation. The Surplus Airport Act further provides that portable Federal airport equipment now abroad, or on a field where it is not being used, shall be donated to any airport under the Act if a formal request is made and the need for the equipment established.

The thinking behind the Bill is probably best summarized in its introduction:

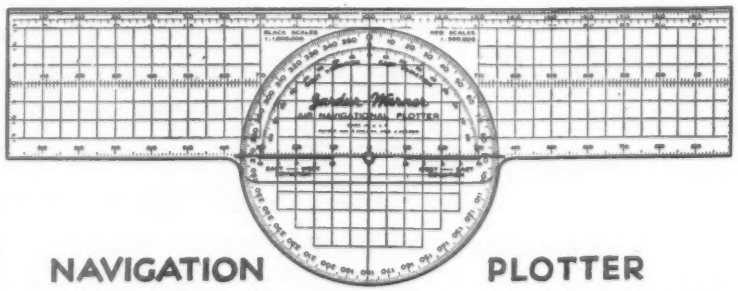
"A bill to assure the disposition of Government surplus airports and airport facilities in such manner as will best encourage and foster the development of civilian aviation and preserve for national defense purposes a strong, efficient and properly maintained nation-wide system of public airports."

A number of other factors, however, also inspired its introduction. In the first place, we must face the fact that our current surplus of military air bases on continental United States represents wartime expenditures which, to a degree, must be written off as peacetime waste. To protect our coastlines against potential enemy attack, many were built under overtime, war-contract conditions, which made it inevitable that they would cost more than if they had been built in peace. Many others were badly located for commercial use. Many, if not most of these, will have to be abandoned in the national interest.

But they are the exception rather than the rule. Scores of others can be worked into the national peacetime airport system and should be kept active for military emergency. To do this with a minimum of red tape and waste is the prime purpose of the Surplus Airport Act.

Another factor which governed the thinking in drawing up the legislation is the function and duties of the Surplus Property Board. It is perhaps possible, without further legislation, that the SPB could dispose of the landing areas without necessity of further enabling laws. But there is a grave danger that if the airport disposal problem is so handled, it will not be carried out in the best interests of the national safety and civilian aviation.

Aviation's interest, so far as airports are concerned, should be made legally paramount. This will remove any danger that good aviation properties, either in the form of landing areas or of airport equipment generally, will be junked or diverted into non-flying channels. It will also remove any possibility of the



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ports getting into the hands of private speculators, to the ultimate damage of local communities and of the over-all national airport system. War-waste is a necessity of war, but peacetime waste of valuable aviation equipment would be folly. To plow up a usable field or convert it into a factory area would be to deny the paramount importance of flying post-war economic and social progress.

To put the spirit of the Surplus Airport Act in terms of national policy that should henceforth be a guiding beacon for the Congress of the United States, every possible measure should be passed as quickly as possible to assure a healthy aviation industry in the United States. We owe it to our program of national preparedness. We owe it to our commercial airlines. And we owe it to the lightplane industry and to the lightplane flyers who proved so thoroughly in World War II that aviation training can and must be the backbone of our national defense. With all Federal air necessary — and the Congress should see to it that Federal aid is not limited by lobbies or by politics — putt-putt flying should be backed to the hilt for the sake of peacetime aviation prosperity as well as for security in case of a national emergency.

That lightplane aviation will benefit by the act is indicated by a breakdown of the surplus airports involved. The figures also indicate the urgent need for establishing procedures for handling the fields once they are released by Army and Navy, which was to be at any time in the immediate future.

The Navy, for example, is already declaring fields surplus in large numbers. Before the end of the year, according to a recent report to the House Naval Affairs Committee by Assistant Secretary of the Navy air John L. Sullivan, 44 large fields and 100 outlying airports will be declared surplus, and by mid-1946 these totals will have risen to 79 major installations and 233 outlying fields, or a grand total of 312. Navy's goal is to reduce the number of major facilities under Navy auspices to 94, as compared with 169 in operation at war's end.

Army plans call for approximately a 50 per cent cut, from an estimated 514 fields under Army management last summer, to 263, leaving a surplus of 251. Of the surplus installations, 160 are principal air fields and auxiliaries. Although no breakdown of figures has been released, it may be assumed that the number of auxiliaries is the greater although, as in the case of the Navy, many will be eliminated as Federal surplus by lease cancellations. Of the remaining fields, 66 are classified as ranges which were used for target practice for gunners and bombardiers, and 25 are listed as miscellaneous installations of doubtful value to civilian aviation. But assuming enactment and proper management of the Surplus Airport Act, civilian aviation large and small should benefit handsomely under the law before the end of 1946.

One other factor should be considered in rounding out the current airport situation — how the funds appropriated by the McCarran Airport Bill shall be expended.

Because the bulk of the money spent on Army and Navy airports now being declared surplus went of necessity into large installations, it is my feeling that the bulk of the McCarran Bill program be devoted to small airports. As a matter of fact, this is exactly what the bill proposes to do. Its national airport plan proposes to increase the proportion of counties with airports from 53 per cent to 88 per cent, bringing from 2,585 to 5,269 the number of communities in the United States having one or more airports. The plan will bring the total number of airports in the 5,000-25,000 population range, of which only 972 today have any sort of landing areas, to a total of 1,487.

Such ports will not only be constructed at comparatively little cost, but will provide more small jobs, especially in

(*Continued on page 78*)

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Already many plans are under way for perfecting airport facilities and equipment; building state and municipal highways to facilitate quicker and more convenient transportation to and from air fields; developing international air transportation; setting up training programs and the study of aeronautics in our school systems; creating commissions charged with promoting aviation wisely and for the benefit of all; and formulating laws and regulations to make the airway the safest of all roads to travel.

These are important programs. Effective promotion of them at all levels of Government can be a major contribution to the welfare and security of our air minded Nation.

We at Bell Aircraft, as part of the Aviation Industry, pledge ourselves to continue the research and scientific achievements which have produced many of our outstanding and victorious air weapons, in order to make the airplane as obedient a servant in time of Peace as it has been a defender of World Freedom in time of war.

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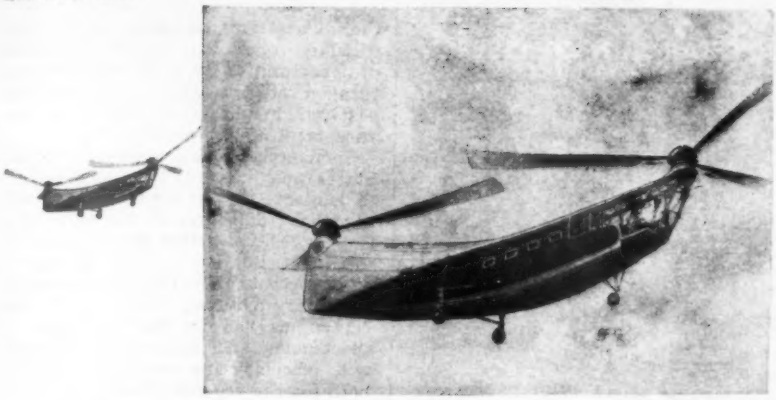

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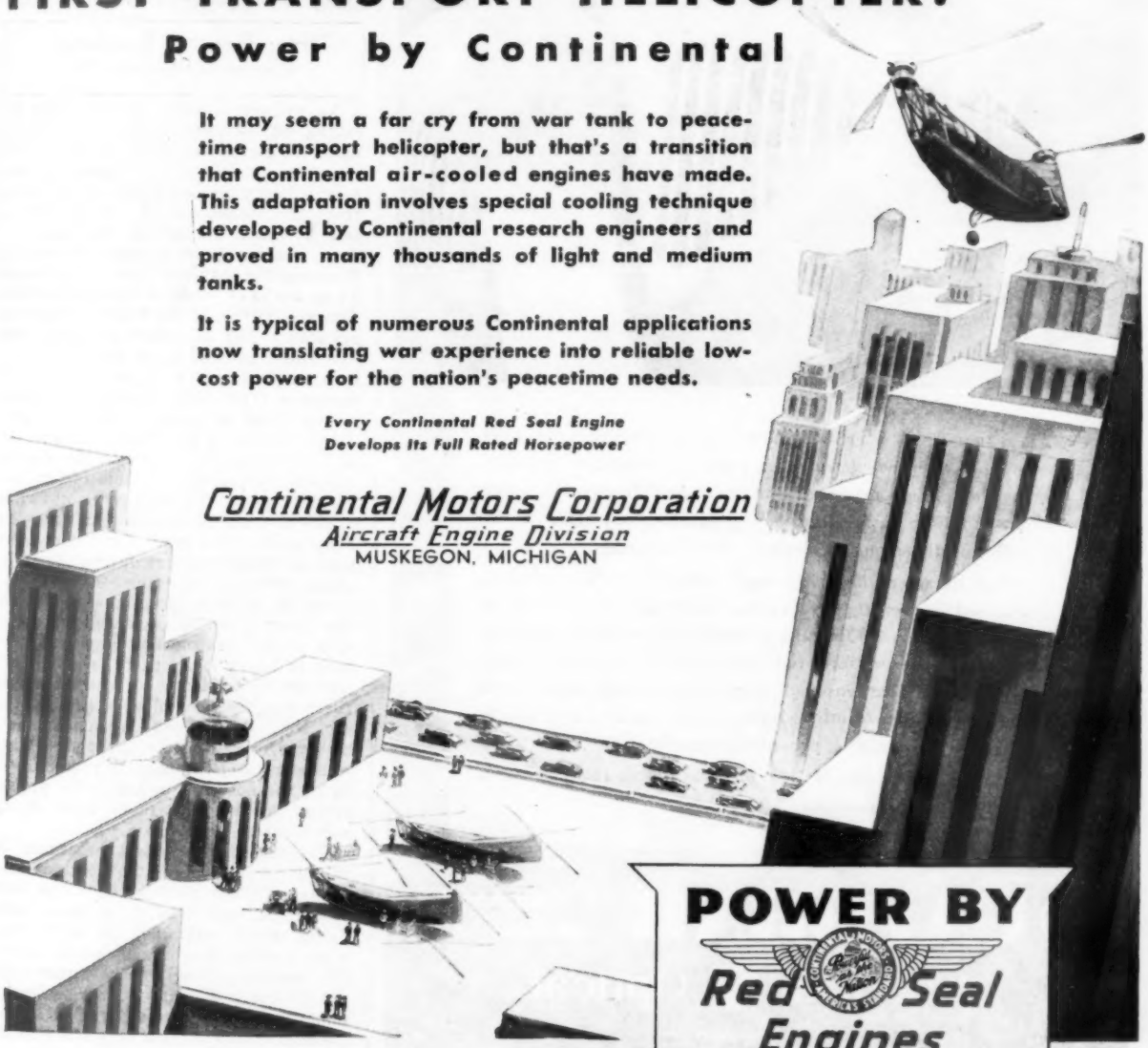

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BUY VICTORY BONDS AND STAMPS

(Continued from page 74)

the airport management field than will large ones, thus opening hundreds of opportunities for employment to returning veterans. Above all, it will put post-war emphasis on the rapid advancement of lightplane flying.

Commercial aviation in the United States today has only to make the effort to dominate the world's airways. It will need help, of course, in the form of a few bigger and better international air terminals. But it's well on its way to an important role in the post-war world.

Military aviation, both Army and Navy, has had its day and done its spectacular and historic job of work with efficiency and amazing speed. But both for the economic health of the industry and the social advancement of the nation, lightplanes and their pilots deserve all possible consideration in the post-war era, and we should do everything in our power to give it. END

Handling the Seaplane

(Continued from page 31)

An important point to remember in taking off — particularly with heavy loads on glassy water — is that, once the plane is definitely on the step, the most efficient planing angle of the floats from the standpoint of resistance is that at which the tail of the floats almost, but not quite, touches the water. Running the seaplane at a flatter angle (nose too low) tends to wet more of the forward bottom of the floats, increasing resistance and diminishing speed, and this effect generally can be felt by increased drop and a slight nosing-over tendency. Conversely, running the floats at too great an angle (nose too high) drags the tail of the floats in the water and will noticeably increase resistance.

As a matter of fact, this latter tendency is one of the most common faults of the average landplane pilot when he first takes to the water, and should be most carefully watched during the early stages of seaplane flying. When an attempt is made to drag a seaplane off the water with the stick well back, the ship "feels" reasonably okay and if it fails to break loose, there is an almost irresistable tendency to haul back still further in the vain effort to get into the air. None but the peppiest of seaplanes, however, can possibly respond to this treatment and the correct procedure is to let the nose fall again to the proper angle and keep it there until flying speed has been reached.

Theoretically, the best procedure in taking off is to plane the floats at that angle at which they produce the least resistance, and hold them there until flying speed is attained, at which time a very slight increase in angle should lift the ship cleanly off the water without difficulty. It may surprise many pilots to learn, moreover, that if the plane is trimmed for a very steep climb, and the controls released as it starts to go on the step, it is quite likely to hit the perfect angle all by itself and actually get into the air sooner than if

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handled by any other than a most experienced and expert pilot.

As a matter of fact, this technique is strongly recommended when making the first flight in a new type seaplane for the purpose of familiarizing oneself with the proper planing attitude, providing of course it is done on calm water and under suitable conditions. On some seaplanes under glassy-water conditions, a slight but quick jerk back on the controls is sometimes of advantage in picking the floats out of the water once the get-away speed has been reached. Another good trick, particularly applicable to lightplanes, is to use aileron and lift one float out of the water at a time. If flaps are available it is generally very helpful to apply them to a modest degree approximately one-third) just before take-off speed is reached. Flaps are likely to hinder getting on the step, however, particularly if used to excess.

Where the water is unusually rough, it is wise to keep the nose of the floats higher than would be correct under normal conditions in order to reduce spray and any tendency to bury. This may cause the seaplane to bounce and stall off before it fully attains flying speed, in which case it is necessary to hold the nose up and settle back for a further run. It is much better, however, than risking the full shock of a large wave on the nose, which might prove serious.

So far as air work is concerned, there is very little to be said, for the average seaplane handles almost identically on wheels or floats. Many pilots have said they could hardly detect the difference even in slow rolls and spins, except when they looked over the side and saw the pontoons. Climb, of course, is slightly reduced by the weight of the floats when an equal useful load is carried, but does not appear as a handicap under average conditions.

Landplane speeds, with a modern pair of floats, have in some cases actually been known to increase. A loss in speed, however, must generally be expected although on normal planes it rarely results in a drop of more than 10 per cent. Generally, longitudinal and lateral stability are not affected by the floats. Directional stability tends to decrease somewhat but in the case of licensed seaplanes this tendency, if serious, will already have been corrected by the addition of a small fin which is usually secured to the tail-skid support under the fuselage, and has been adjusted to return the ship to normal directional characteristics.

Landings on floats can be made identically to landings on wheels, except for the broader safe range of attitudes for the seaplane from tail high to tail low. On the other hand, it is extremely important to select the correct type of landing for varying water conditions. If the water is rough, particularly with no wind, make the steepest possible stall with maximum flap if you have any. The idea is to hit as slowly as possible and avoid clipping a wave with the nose of the floats, which at high speed might cause structural damage and would undoubtedly toss you up into a dangerous stall.

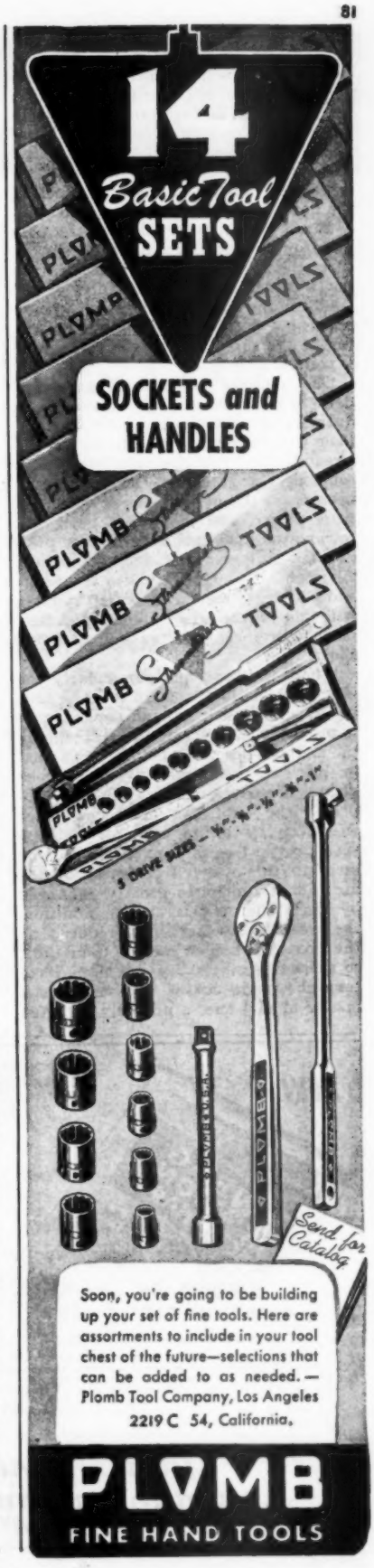
Really steep stalls are not easy, and it's not a bad idea to practice them occasionally. Stall landings are always safe but somewhat unpleasant on reasonably calm water, and under normal conditions a semi-stall is recommended. In this case the tail and step of the floats touch the water more or less simultaneously, resulting in a slightly faster landing than the conventional three point on wheels. If the water is really quite smooth, still faster landings can safely be made by bringing the craft in with considerable excess flying speed and letting it touch the step in full planing position. Great care should be taken, however, not to carry this idea too far, since nosing over tendencies are likely to be developed, while powerful forces inevitably will be applied to the float structure, which in some instances have proven disastrous. Furthermore, any type of fast landing requires considerable skill to accomplish correctly.

In addition to considering the methods of taxiing in normal weather, as discussed above, I believe it will be helpful to append some comments on maneuvering on the water under storm conditions, where high waves and winds of real force are encountered and where the danger of capsizing must be seriously considered. Obviously, the safest position on the water is that heading directly into the wind, and in a strong blow the pilot should make every effort to land at such a point that the ship can be maneuvered on an approximately upwind course to the landing float, buoy, or beach. Furthermore, if the area in which he has first landed will not permit taxiing on an upwind course, he frequently will find it advisable to take off and go around again rather than risk any cross-wind water maneuvers.

Whenever a pilot must taxi the plane in other than an upwind direction, the "sailing" method is always the safest to use, assuming of course that the wind has sufficient velocity to give the ship an appreciable backward drift when heading into the wind with an idling motor. Under these conditions, a directly downwind, tail-first course is naturally very easily accomplished.

If the pilot desires to shift from a straight downwind, tail-first course by a reasonable margin, he should first retract the water rudders and will find that he can then steer with the air rudder by pointing the tail of the seaplane in the desired direction. Incidentally, cutting one switch and retarding the spark are helpful in accelerating the drift as well as opening the doors and lowering the flaps, if any. If, however, his course is to be across wind or somewhat upwind he should open the throttle sufficiently to stop any backward drift and keep the nose of the ship pointed in the direction desired.

When the pilot is in doubt as to whe-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ther to point nose or tail toward his objective, a little thought on the theories involved will generally answer the question. When backward drift is fast, the wind effect on the plane is negligible (except in producing drift), and the plane naturally travels through the water in the direction in which the tail is pointed because of the keel effect of the floats. On the other hand, when, as a result of propeller thrust, there is little or no backward drift or motion through the water, the keel effect of the floats is negligible and the force of the wind on the fuselage moves the plane more or less sideways through the water in the direction in which the nose is pointed.

The relative amount of backward drift is the determining factor. Consequently, in some cases, both methods have to be employed to achieve the desired result. For instance, the pilot could first work directly cross-wind by heading in the desired direction with a little power, and then drift back, tail toward the goal, until the correct position is finally reached. It is important to remember, however, that in any backward drifting maneuver water rudders will oppose the air rudders and they must therefore be retracted as noted above.

Where the wind and particularly the waves are not high enough to make sailing imperative but are sufficiently great to prevent maneuvering the seaplane by the methods described before, or at least to prevent these maneuvers without picking up excessive spray on the propeller, the pilot can often maneuver effectively by taxiing at relatively high speed, with the ship partially on the step. In this way effectiveness of the air rudder control is greatly enhanced by the higher slipstream. In addition, the weathercock action is reduced as the floats are hauled back on their tails, so that it becomes very much easier to turn the plane out of the wind. As a matter of fact once a properly executed step turn is started the plane may lose all tendency to weathercock and actually help itself complete the turn without further use of rudder. Frankly, however, "step turns" require an excellent feel of the machine and the inexperienced pilot courts trouble when he tries them. Nevertheless, these maneuvers are somtimes exceedingly useful and because the theory and practice of them adds enormously to the understanding of seaplane handling, I shall discuss them in considerable detail.

When a twin-float seaplane is traveling partially on the step at speeds of perhaps 20 M.P.H., the ailerons are relatively useless so far as lateral control is concerned. Curiously enough, however, the rudder — which at slower speeds is useful only for steering — suddenly becomes, under these conditions, a most powerful factor in lateral control. Indeed, the secret of successful high speed water maneuvers lies almost entirely in its judicious use.

Just as a bicycle rider instinctively turns his wheel to the right if he commences to lose his balance and fall in that direction, so an experienced seaplane pilot automatically kicks right rudder as he feels his starboard wing dipping low to the water. In the case of both bicycle and seaplane, the rudder movement brings into play the righting effect of centrifugal force, which the resulting turn develops.

As a practical example, suppose that a left hand "step turn" of 180 degrees from an upwind position is to be made under adverse wind and water conditions. The pilot's first move is to slam the throttle wide open and pull up the nose of the floats on a directly upwind course, exactly as if a take-off were to be made. He uses no rudder at the outset, since he wants to get the full (into-the-wind) lift of the wings in order to shorten the time required to raise the bow of the floats through the spray point and bring the craft to a partially planing conditions. Once the seaplane reaches this position, the pilot eases off the throttle to prevent gathering more speed and to keep the plane from getting entirely on the step. At the same time he applies left rudder generously —varying the amount in proportion to his speed and the strength of the wind.

As the seaplane swings to the left and approaches the crosswind position, the pilot may have to open the throttle gradually and in all probability ease off on the rudder due to the reduction in weathercock action. Likewise, as the aircraft swings farther to the left and approaches a downwind course, the pilot must reduce the amount of throttle to prevent the plane from gathering too much speed. The idea is to apply just enough power at all times to keep the floats bow high and well clear of spray in a semi-planing condition. If the speed were allowed to increase to a point where the craft reached a full planing position, the bow of the floats would drop, with a resulting loss in seaworthiness, an increase in weathercock and a tendency to porpoise.

Throughout the whole movement, the rudder is the control, and it must receive the most careful attention, since upon it the lateral balance of the ship, as it passes through the adverse crosswind position, depends almost entirely. More rudder and (incidentally) more power are needed as the strength of the wind increases, to intensify the anti-capsizing forces. With the turn once started, the pilot should abandon all idea of following a preconceived course and concentrate on lateral stability until he has reached a downwind heading. Naturally it goes without saying that the area in which the turn is to be made must be free from obstruction, for a sudden easing off of the rudder in order to avoid a collision during the middle of the turn might easily cause complications and trouble.

Once the craft is heading downwind, the pilot should reduce the throttle to

(*Continued on page* 86)

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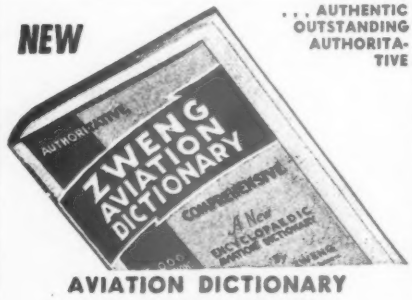

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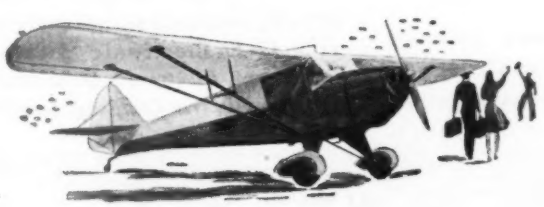

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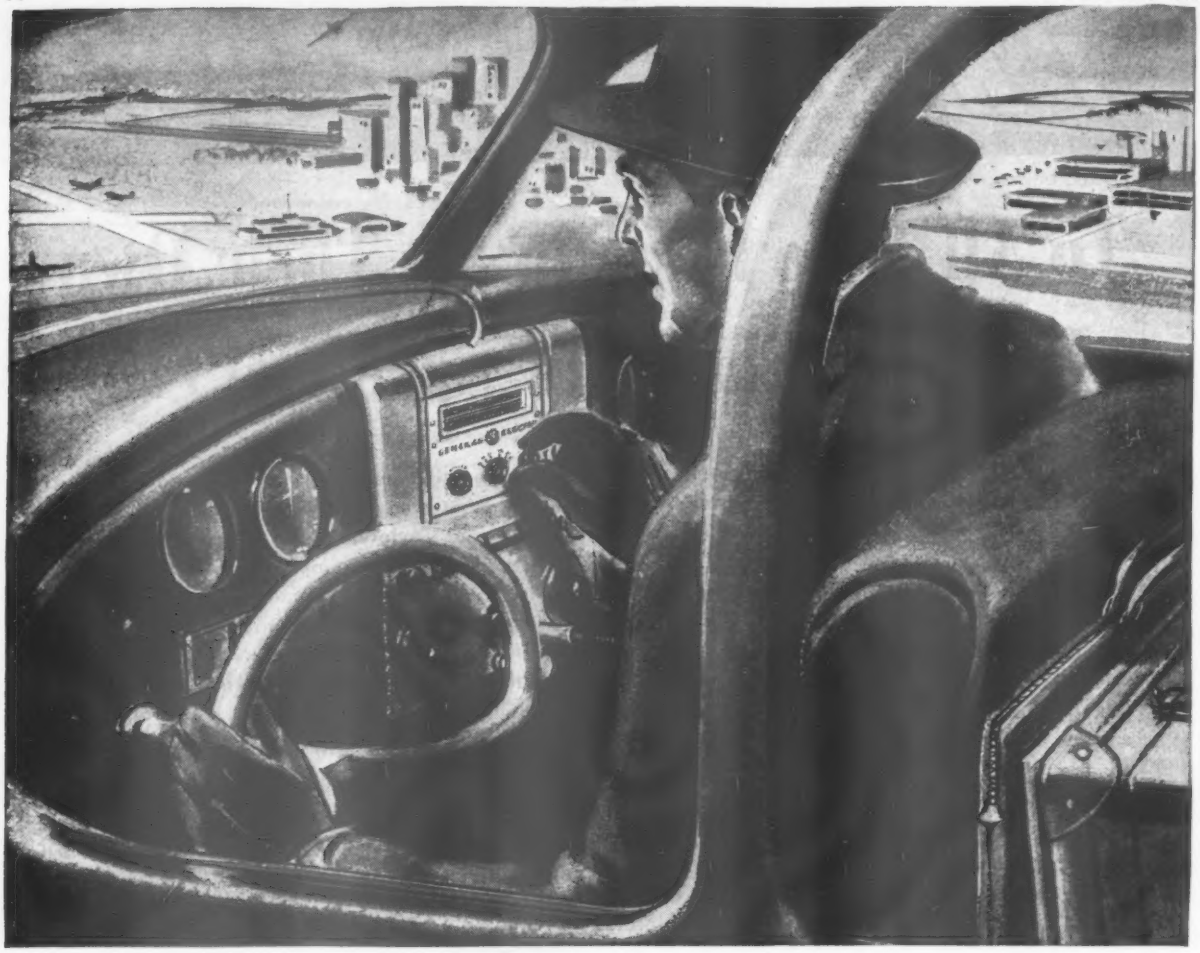

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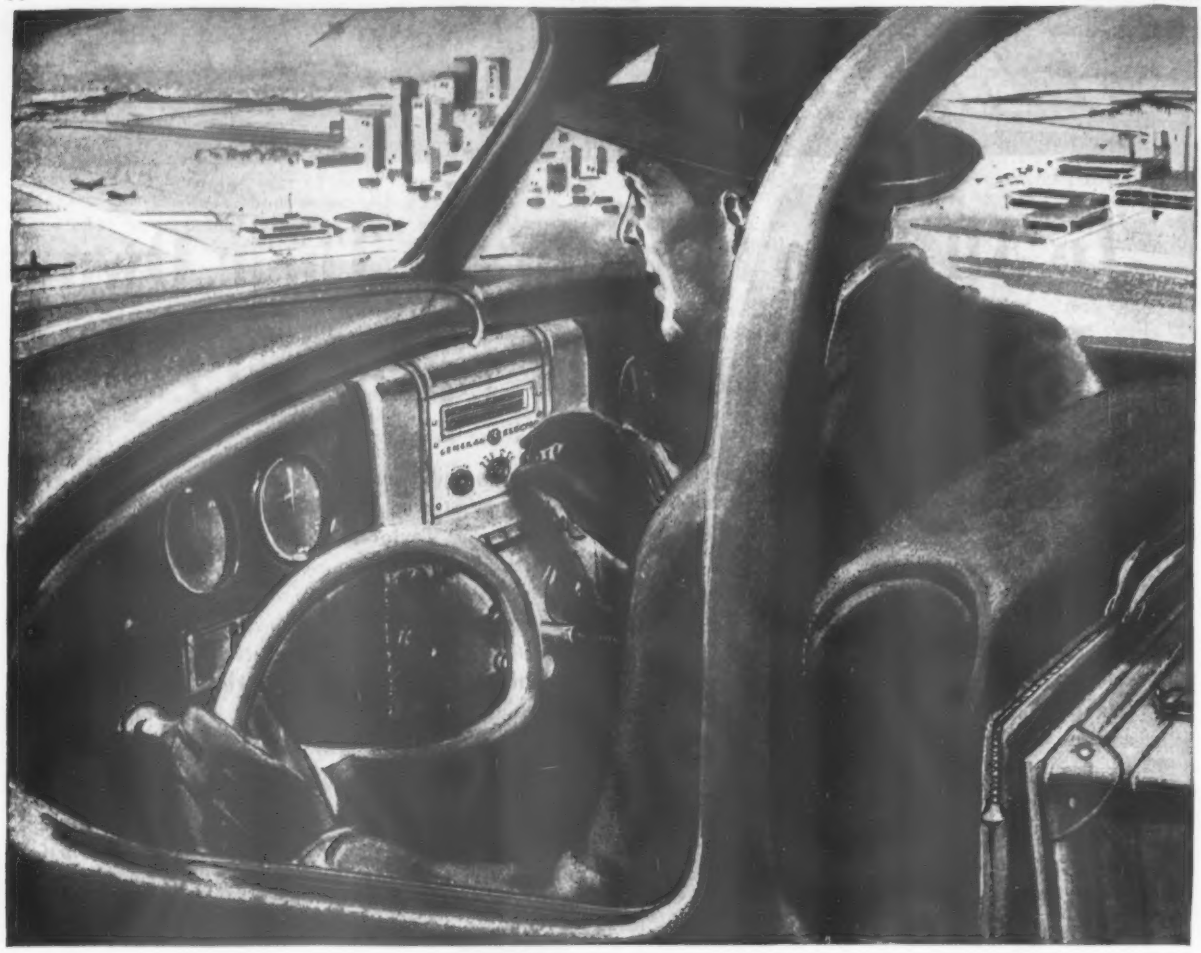

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(*Continued from page 82*)

a point where the bow of the floats is just comfortably high and free from spray. In this condition he can safely taxi for any reasonable distance. If he now wishes to make a turn back into the upwind position, he should cut the throttle down slowly until propeller spray begins to be encountered — then quickly cut it completely.

He then allows the aircraft to coast along until as much forward speed as possible has been lost, and only then should he apply the rudder (preferably left rudder with normal clockwise engines). Ordinarily the craft will quickly and safely swing into the wind. The importance of *not* using power when turning *into* the wind, and resulting likelihood of capsizing, were previously discussed last month.

An interesting example of the "sailing" and "step turn" methods of adverse weather maneuvers is presented in the problem of taxiing to an object some distance away and more or less directly cross-wind from the starting point, a problem which in fair weather would simply be a matter of applying rudder and a little power. With high wind and waves, however, the fair weather method usually proves impossible and sailing is the safest and easiest plan to follow, holding position with the throttle, applying full rudder and moving sideways until the objective is reached. Sailing is slow, however, and step turns are quite in order if conditions are at all within reason.

It is important, however, to avoid the mistake of making the turn and then attempting to taxi at speed, on a steady course cross-wind, for if you do the plane will develop a strong tendency to capsize, through lack of a righting couple, as soon as the turn out of the wind is completed. The proper maneuver is to start the turn and keep turning until you reach a downwind course — then idle around into the wind and either taxi directly upwind to the objective, or make another or, if necessary, a series of similar evolutions until the desired position is reached.

Before closing, I believe a few suggestions of a general nature may be worth considering:

Never land in rough water if smoother water is just as convenient. Pick out a cove, the lee side of a point, a dock or large boat. It is much easier on the floats as well as the entire airplane. Likewise, never land on absolutely glassy (dead smooth) water if you can avoid it. It is unbelievably difficult to judge one's altitude above it and for this reason extremely dangerous. If you must do so, however — land close to the shore, buoys, boats or other objects which will give you the water line. Keep your eyes on them rather than the water ahead. If it is absolutely necessary to land in a large open area of glassy water, don't attempt to glide down lower than about 50 feet. Settle the rest of the way — nose up — with power.

Watch the water for streaks which always run parallel with the wind and can be depended upon accurately to chart its path. If there is any doubt as to which of two directions the wind is blowing (such as north or south), remember that the waves move faster than the foam (which is drifting on the surface) and they appear to be moving through it. Normally waves are at right angles to the wind, but in a shifting wind, waves will not change at once and only the streaks can be depended upon to give the correct direction. Seagulls on the water quite consistently head into the wind, but don't count too much on boats at anchor, for currents and tides can easily swing them the other way. If the wind is so light you can ignore it, watch for signs of a current and always land and take off with it—not against it. A 10-mile current (occasionally encountered) will considerably hamper a take-off attempted upstream.

Always keep a weather eye open for tall masts and small boats when taking off or landing in congested areas, and remember that they may rapidly change position. In the same way, watch out for driftwood, logs and stumps, when operating in strange waters. They are not so hard to see if you are on the alert when landing. For a take-off, however, a wise plan is to taxi slowly downwind—then turn and take off along the path which you have in this way carefully looked over. Even then, before you start, take a good look to make sure

(*Continued on page 90*)

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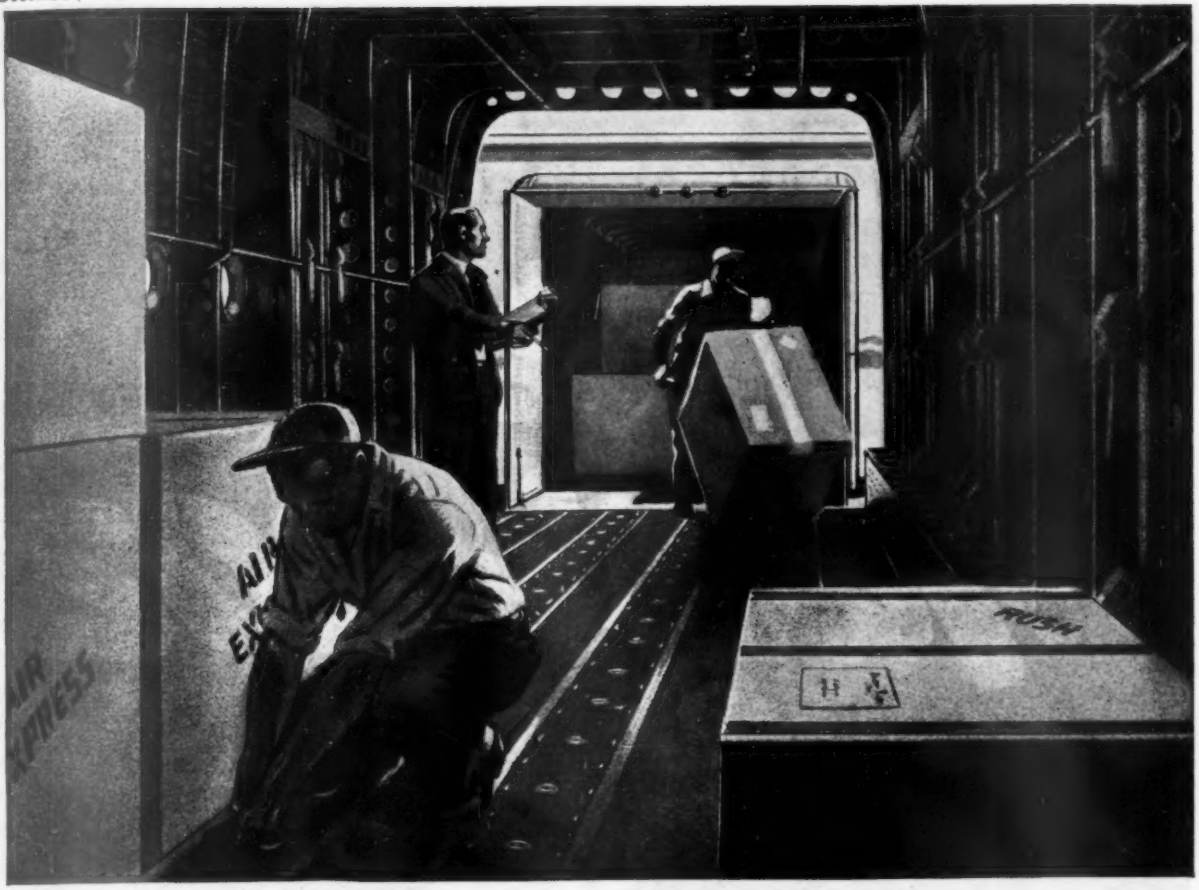

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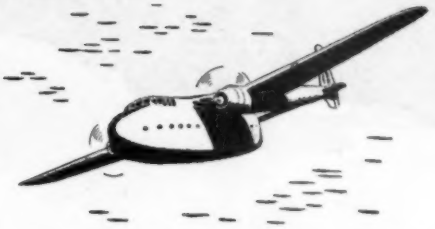

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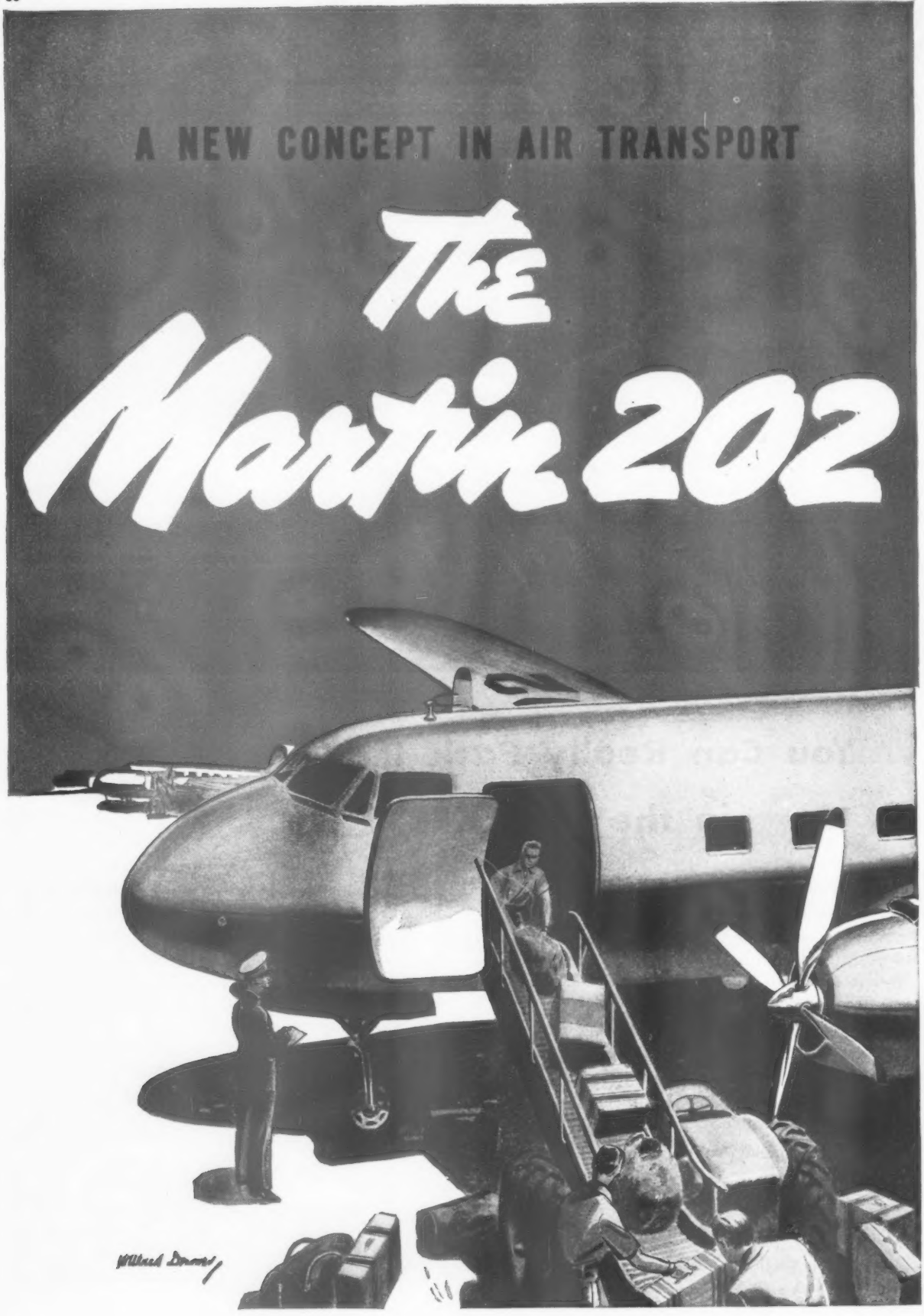
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(*Continued from page 86*)

something has not drifted across your path.

In picking up a buoy, it is convenient to have a passenger climb down on the deck of one of the floats and stand by with a short length of line, one end of which has already been temporarily secured to a strut. You should then taxi the plane slightly to the right or left of the mooring, so that the float on which the passenger is standing will be brought directly within easy reach, but always *keeping the buoy on the outside.*

If a strong wind is blowing, run the plane up until the buoy is about alongside the center of one of the pontoons and then rudder hard, so as to swing the near pontoon against the buoy as the switches are out. In this way the wind will hold the pontoon against the buoy as the craft drifts backward and will allow ample time to make fast. If no assistance is available it is convenient in many cabin planes for the pilot to get out and stand on the port float in such a way that he can reach the rudder pedals (as well as the switches and throttle) with his hand and in this way taxi the plane, while at the same time he is within handy reach of the buoy, as he idles alongside.

Once fast to the buoy, it is advisable to moor with a bridle running from the bow cleats of the floats. These cleats are designed to carry any normal mooring loads but if a plane is to be towed in rough water or hauled up a ramp it is advisable to make fast to the base of the main struts or the special tow fittings which are provided on the larger float gear. It will be found very handy to carry a mooring bridle in the plane, and a large snap hook with eye splices at either end just large enough to push snugly over the bow cleats, is recommended for the apex.

When leaving a mooring, cast off all lines except one, which can be held from one float. If no assistance is available it is often possible to make fast one end of this line to a strut, running the free end through the eye in the buoy, and back to the float, where a simple turn can be taken about some object within reach of the pilot. After the engine is started the pilot can then let the free end pass through the eye in the buoy and at his convenience can pick up the line from where it is fastened to the float.

In working to a low dock or float which will clear the wings of the plane, approach slowly from alongside instead of directly toward it if conditions permit. A helper on shore can then conveniently seize a wing tip and, with the switches out, easily draw the craft in and make fast. However, when receiving an incoming seaplane from a landing float which has been properly protected with automobile tires or the equivalent, it is important to put the wing straight in as the craft idles alongside so as to slow it down by forcing the side of the inboard pontoon against the tires. If an effort is made to stop the seaplane by holding back on the wing tip, the craft is almost certain to swing and bang the nose of the inboard pontoon into the landing float. If no helper is available on shore it is frequently possible to get out on the inboard pontoon and do a reasonable fending off job from there.

Keep an eye out for excess weight — which seems to be most easily acquired on the water where extra anchors, rope, covers, etc. are frequently loaded aboard. Likewise, make at least an occasional check for water in the floats. A loose handhole cover can easily flood a compartment and it takes only a dozen gallons of water to add a hundred pounds. If it is inconvenient to make a careful inspection, a glance at the water line will tell the story when you are familiar with your seaplane.

See that your propeller is set to develop its maximum rated r.p.m. at wide open sea-level flight on floats. Propellers should usually be reduced in pitch for maximum efficiency when switching from wheels to floats, and in many planes the top speed and particularly the take-off will be seriously impaired if the change is not properly made. Check up on your idling adjustment, too. When operating a seaplane it's extremely important to have an engine that idles slowly and dependably.

If your engine should stop when flying over land on floats, don't be disturbed or make any silly maneuvers in a frantic search for water. Pick out a nice field instead and bring her in a bit fast, and partially on the step, with the easy assurance that hundreds of pilots have done it before you — both accidentally and on purpose, without any damage at all. The main thing is to keep plenty of control so as to assure a smooth, even landing — with this accomplished there is nothing to fear in the line of structural damage or nosing over, if smooth grassy ground without stones is selected.

If your floats are equipped with water rudders, be sure that they have an ample throw. Thirty to 35 degrees either way from neutral is a normal setting. See that the wires are snug and that there is no lost motion. Insufficient movement seriously reduces the effectiveness of control.

In reading these notes, the uninitiated may possibly gain the impression that the average seaplane is ready to capsize at the drop of a hat and that none but a first-class tight-rope walker can expect to handle one with safety on the water. Quite the contrary. The emphatic words of caution in regard to operating under storm conditions were written principally as a warning to the inexperienced and over-ambitious pilot.

In reading these notes it is well to remember that landplanes as well as seaplanes require careful handling in winds of near gale force, particularly small landplanes with light wing loadings. As a matter of fact, it is generally recognized that with suitable handling, a seaplane can be safely maneuvered in higher winds than the equivalent land-

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plane, providing the waves are not too high.

The more or less mythical difficulties so frequently associated with seaplanes can be readily attributed to the fact that water flying is different, much less commonly practiced, and hence more mysterious. But then, similar superstitions afflicted all flying a few decades ago. As a matter of fact, the seaplane is the safest and easiest craft to learn to fly, and without a doubt the most pleasant and safest type in which to put in the first 100 hours of solo. Out over the water with an endless airdrome in every direction, it's a simple matter to practice landings and take-off's without the strain of having to make them in restricted quarters. Moreover, forced landings in the first few hours of solo are no longer a hazard, and the difficulties with brakes, the danger of ground loops and nose-overs, and the problem of crowded airports can all be postponed until a background of simple flying has been safely and fully mastered. END

Instruments for the Private Flyer

(*Continued from page 24*)

will probably follow the history of the automobile instrument panel. Many pilots of the future will not be skilled in the engineering art and thus will not understand the reasons for "pounds per square inch," "degrees Fahrenheit," "inches of mercury" etc. It is only necessary that the instruments show that the particular operation is within a satisfactory and safe range. Since the aircraft is going to require more instruments than the automobile it becomes doubly important that the design arrangement and indication be as simple as possible.

A second objective in instrument design and arrangement is that the indication of the instrument be one that corresponds to natural instincts in causing pilot reaction. The most obvious problem in this regard is the compass illustrated by Figure 1. With the conventional compass the observer sits in an imaginary position beyond the earth and outside the horizon. Actually his position is directly above the center of the earth and the horizon forms a continuous circle around him. The compass should be so designed that its reading indicates the true relation of the airplane and horizon. This will require a radical departure from the conventional compass and will force the development of a linkage between the magnetic needle and another needle and scale which functions in a manner similar to that of the airplane with respect to the horizon.

The objection to the conventional compass and directional gyro is that the pilot must take time to figure the corrective action which will bring the airplane back on course. With much practice the procedure becomes almost instinctive, but with the great majority of private pilots it will still be a matter for calculation and trial each time the course must be corrected.

In the case of the radio compass indicator, the practice of "follow the needle" was adopted. If the airplane was headed to the left of the radio station, the compass needle would point toward the station, and, therefore, to the right. It was only necessary for the pilot to follow the needle, and turn right to put the airplane back on course.

The compass indication shown in Figure 1 is an adaptation of this idea. The card turns and since only the top half appears it stimulates the horizon in front of the pilot. The correct course can be set on the card to serve as a landmark, much as a mountain peak on the true horizon would serve. If the airplane is off course to the left, the peak and the course marker will appear to the right. The pilot turns right to head towards the mountain peak and to bring the course marker to the zero heading.

A third objective is to provide a minimum number of instruments for safe flying. It is realized that there will be two minimum numbers, one for contact flying and one for instrument flying. No less than this minimum should be acceptable in any airplane. For contact flying the minimum should include the instruments tabulated below:

- Engine—
  - Tachometer
  - Oil pressure
  - Oil temperature
  - Fuel quantity
  - Fuel pressure
  - Carburetor air temperature
  - Coolant temperature
  - Manifold pressure
- Navigation—
  - Compass
  - Air speed
  - Altimeter
  - Rate of climb
  - Clock
  - Radio receiver
  - Radio transmitter
- Other—
  - Outside air temperature
  - Landing gear
  - Flap position
  - Ball inclinometer

Some of the eninge instruments are dependent on the engine selection. Coolant temperature of an air-cooled engine will be a cylinder head temperature indicator. A manifold pressure indicator is needed if a constant speed propeller is used.

A recent Kollsman Instrument-AOPA survey indicated pilot interest in the following additional types of instruments, gauges and auxiliary equipment which would serve to provide greater degree of safety and efficiency:

Absolute altimeter, radar, ground speed indicator, r.p.m. recording tachometer, engine and air time recorder, pitot tube and mast heater, panel light to show if one

(*Continued on page 96*)

to get there **SAFELY**

When you know that special engineering features make the Funk B-75-L one of the *safest planes* in the air . . . practically spin-proof and stall-proof.

QUICKLY, because it's powered by the famous Lycoming 75 H.P. dual ignition motor, known for dependability.

MORE ECONOMICALLY; with low initial and operating cost. You'll be amazed at the time and money saved when you fly the dependable Funk plane.

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Transforms the forces of War

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More Planes Will Be Built . . and More People Will Travel and Ship by Air

because of the

Gilfillan RADAR LANDING CONTROL

This great radar achievement of the war is now ready to serve plane manufacturers by emphasizing the safety factor in air travel. Planes can now be landed safely through fog, storm, darkness — and around such invisible hazards as mountains, buildings, high-tension wires, etc.

To airplane manufacturers Gilfillan Radar Landing Control means:

★ Increased demand for new planes

★ Increased private and commercial air traffic

★ Increased acceptance of air travel by the public

Gilfillan Radar Landing Control requires no special plane installation—planes with standard airplane radio equipment can land with safety through ground installation and operators who "talk the pilot down" with precision.

The magic of Gilfillan Radar Landing Control is complete.

It —

1. Brings planes onto any air field safely through fog, storm, darkness and other flying hazards.
2. Guides planes safely around buildings, mountains or other aircraft under all weather conditions.
3. Has been proven beyond question through thousands of landings under emergency conditions.
4. Will handle any type of aircraft.
5. Controls many planes at one time and keeps them circling in the air if necessary at different elevations to prevent collision.
6. Can land a plane every thirty seconds.
7. Can be installed anywhere.
8. Supplements — does not displace — present airport control equipment.
9. Requires no special equipment in the airplane.

The Gilfillan system, developed in 1942 and put into practical usage in 1943, was especially designed to land airplanes under adverse conditions and is not a modification of some other radar system.

This equipment was first used in Europe and has since been of incalculable help to our flyers in the Pacific in the adverse weather conditions under which they have operated.

Available NOW FOR ALL AIRPORTS

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CABIN TEMPERATURE CONTROL—

A new electronic system, which controls cabin temperatures with extreme accuracy, has been applied to both steam and combustion type aircraft heaters. Three temperature sensitive elements in the system keep the cabin air at the selected temperature by maintaining the heat supply equal to heat losses. Overshooting is prevented by accurate control of heater discharge temperature.

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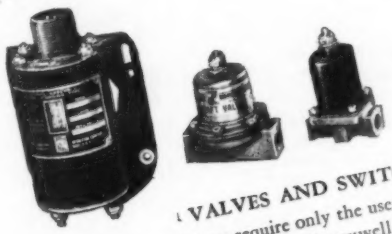
Increased operating economy and longer engine life is assured by automatic engine temperature regulation. The Honeywell control system, which can be applied to either electric or hydraulic actuators, maintains cylinder head temperatures on one or more engines within a few degrees of the temperature selector setting. Because of its small size and proximity to the combustion chamber, the temperature sensitive element, responds accurately and quickly to temperature changes.



VALVES AND SWITCHES—

Many aircraft control problems require only the use of electric valves or pressure operated switches. Honeywell valves and switches are scientifically designed for maximum dependability and minimum weight. Typical units are the Altitude Warning Signal Switch, which sounds an alarm when the pressure in a pressurized cabin drops below a safe minimum, and the two solenoid valves for heater control illustrated here.

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TODAY we can point with pride to the creative engineering by Honeywell which helped produce Allied air supremacy and resulted in decisive victory. Tomorrow, this same creative engineering will help to improve performance of all types of aircraft. Even now it is helping aircraft designers and manufacturers with any and all problems. The Honeywell program includes a complete flight research department, test aircraft, and thousands of dollars worth of testing equipment. In addition, trained application engineers, with broad experience in the use of aeronautical and industrial controls, will collaborate with aircraft manufacturers and airlines in developing the most practical equipment for each specific problem. Their work includes consulting service and flight testing at the customer's plant. These men can help you in the application of Honeywell equipment to your control problems. Minneapolis-Honeywell Regulator Company — Aeronautical Division, 2948 Fourth Ave. S., Minneapolis 8, Minn.

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MINNEAPOLIS **Honeywell** CONTROL SYSTEMS

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AIR NAVIGATIONAL PLOTTER

- Eliminates need for straight edge, dividers, distance scales.
- Useful on portions of charts where other plotters are useless.
- A compact precision instrument with a tolerance within a fractional part of a degree.
- Useful in piloting, dead reckoning, radio celestial navigation.
- Can be used to plot radio bearing from D.R. or station position.
- Can be used for drawing, measuring true and magnetic courses.
- May be set for direct reading of variation and deviation.
- Eliminates need for small charts in setting celestial fix plot.
- Every part made from lifetime Vinylite which will not shrink, warp or discolor.

SPECIAL PILOTS' PRICE.....$4.00
Postpaid

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KOLLSMAN PITOT-STATIC TUBE
(Electrically Heated)

Streamlined, shark-fin design. For horizontal mounting. Precision-Built.

Automatic Current Control. Hermetically sealed for weather-free operation. One piece copper shell with high nickel finish.

Where icing conditions are not normally encountered, the heating unit does not have to be utilized.

Rated 24-28 V. at 130 Watts. 2 heaters, single wiring (can also be used for double wiring). Complete with couplings.

List.....$38.00

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U. S. GAUGE AIRSPEED INDICATOR

Range 0 to 500 M.P.H.

Type 2200

Two scales 0 to 300 and 300 to 500 M.P.H. in standard graduations of 5 M.P.H. Pointer makes 1¾ revolutions throughout full range. Bronze diaphragm and hard bronze movement mounted in a sturdy cast brass frame to insure rigidity. Black Bakelite case with self-locking nuts in mounting lugs.

Radium Dial, 2⅜" Diameter. Connections 7/16"—20 male back. Complete with Pitot and Static Couplings.

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(*Continued from page 92*)

magneto should become inoperative in flight, carburetor ice warning indicator, and a reserve fuel tank with a gauge calibrated in hours of flying time at a specified cruising speed at a stated altitude—Ed.

For instrument flying the navigation list should be augmented with:

Flight indicator
Gyroscopic compass
Turn and bank indicator
Marker beacon
Radio compass

The last two radio items are admittedly luxury equipment.

The arrangement of instruments on the panel has been a source of much discussion. The desirability of a standard instrument arrangement whereby a pilot would feel at home in any airplane is unquestioned. However, it is quite likely that a standard arrangement will never be achieved due to the aircraft design relations and the greater importance of other factors such as aircraft performance and cockpit appearance.

A private pilot possessing an unusual amount of experience, Roy McGuire, has suggested an arrangement similar to that shown in Figure 2. This design will achieve the similarity and standardization within aircraft types which was recommended above. Since the rate-of-climb indicator operates best from a horizontal neutral position, this fixes the cruising position of all indicators. It is Mr. McGuire's suggestion that the cruising speed of the engine be so set that the tachometer needle will be in a correspondingly horizontal position at cruising R.P.M. He also suggests that the air-speed indicator be set in this same position so that cruising speed will cause that indicator to align itself with the others. With such an arrangement all instruments will align themselves along one horizontal line under cruising conditions. It is not necessary for the pilot to know his engine operating conditions or aircraft characteristics in terms of R.P.M. and M.P.H. It is simply necessary for him to adjust the throttle and attitude of the airplane to align the indicating needles and he knows that the airplane in operating at its best point. This solution may be expensive since it requires the grouping of four instruments around a central instrument with gearing to coaxial pointers.

To avoid this expense, the arrangement shown by Figure 3 may deserve consideration. This utilizes the McGuire suggestion but uses separate instruments instead of the combined instruments. In any event there is much to commend McGuire's idea of simplified operation. It is known that power plants and aircraft performance will differ with the individual designs, but there is no good reason for making operation of the airplane any more complicated than necessary.

Final objective of the instrument arrangement is cost. The cost of an adequate instrument panel must be kept as low as possible. It is quite likely that aircraft manufacturers will follow automotive precedent and subcontract the entire panel. The selling price of this panel

(*Continued on page 100*)

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FIVE HUNDRED MILES from Base, the Catalina crew sighted a Jap task force! Frantic Jap carrier fighters made attack after attack. Inside a wounded radio operator struggled to repair his shattered transmitter. Painfully his fingers beat out an emergency—alerting all American naval forces. He kept on sending until the disabled "Cat" crash landed into the sea . . . On the life raft he still stuck to the job—cranking out S.O.S. on Gibson Girl, the emergency set, until his crew was rescued.

He was 22 years old—and what he did took more than guts . . . it took plenty of knowledge and skill. Command, liaison and interphone radio sets, radio compasses and navigational aids and radar devices were the tools these men worked with.

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He and tens of thousands like him have mastered new, complex and varied skills . . . and hold within them magnificent promise for the future of American aviation.

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WHETHER YOU'LL NEED *an instrument oil to lubricate delicate aviation instruments . . . or a super-fuel or super-hydraulic oil, choose an Esso Aviation product—it will have behind it experience that began with the birth of aviation at Kitty Hawk, plus unequalled research and testing.*
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A letter addressed to "Service Department" will put you in contact with the men who, during the war, produced exhaust systems, heat exchangers, jet engine parts and many other products for the country's leading airplane manufacturers.

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Swooping in smoothly on emergency runways results from consummate skill by the pilot combined with efficient shock absorption by Aerol landing gear. ◆ Aerols have contributed to aviation's progress for almost 20 years, and new units now being developed for future giants of the sky, testify to the importance of Aerols in post-war aviation. ◆ Our products, serving many industrial fields, are mentioned below. Whatever your needs, Cleveland Pneumatic engineers offer you the benefit of over 50 years manufacturing experience.

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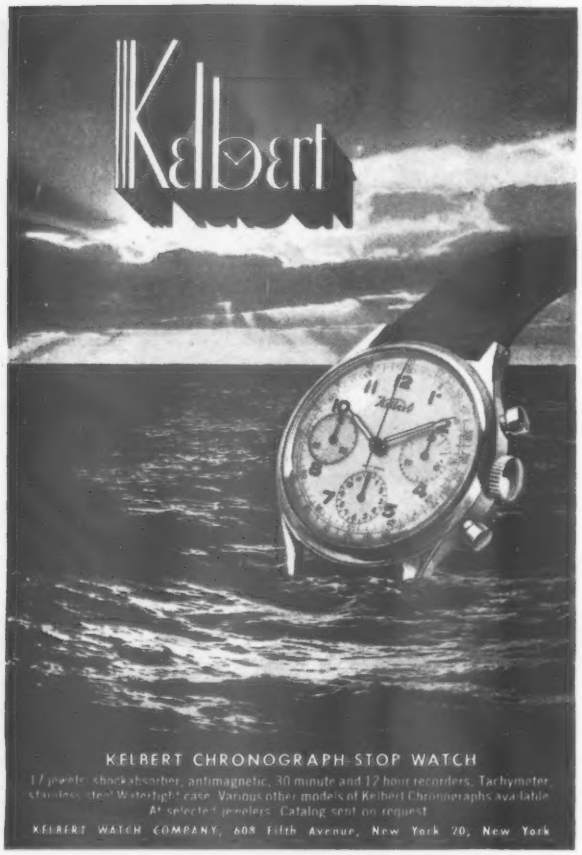

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(*Continued from page 96*)

ready for installation in the airplane should not be more than five per cent of that of the airplane. This means that the sales price of a complete instrument panel for a $2,000 airplane should not be more than $100. The radio equipment should be considered as part of the instruments. Nevertheless, it is quite likely that it will be considered extra. If the radio equipment is considered as extra, the top price for the instruments for the private airplane should not be more than $150. This price is intended to include all the instruments required for instrument flying.

It is obvious that instruments available today will not meet the objective enumerated above for simplicity, naturalness, adequacy, or cost. This fact presents a tremendous opportunity for those skilled in instrument design. END

. . . The Same Mistake Again?

(*Continued from page 23*)

ness." And Secretary of the Navy Josephus Daniels led the opposition by offering to stand on the bridge of a ship while an attempt was made from the air to bomb it, later getting confirmation from Navy Secretary Wilbur in 1924, who said, "I regard the statement that the next war will be in the air as an absurdity, partaking of the Jules Verne type of literature."

On the Army side, Maj. Gen. John L. Hines contributed the startling opinion that "the airplane is never going to take the place of the cavalry."

Yet General Mitchell was court-martialed by a distinguished panel of his peers—including none other than Gen. Douglas MacArthur.

Nor did the developments of the '30's and the spectacular advances of the German *Luftwaffe* drown the protests of those favoring land and sea equipment over airplanes.

"Army aviation," declared Admiral King at the beginning of World War II, "should end at the shoreline. I shall do what I can to make it so." As late as 1942, he stated: "It is not fundamentally true that air forces can control permanently either land or sea."

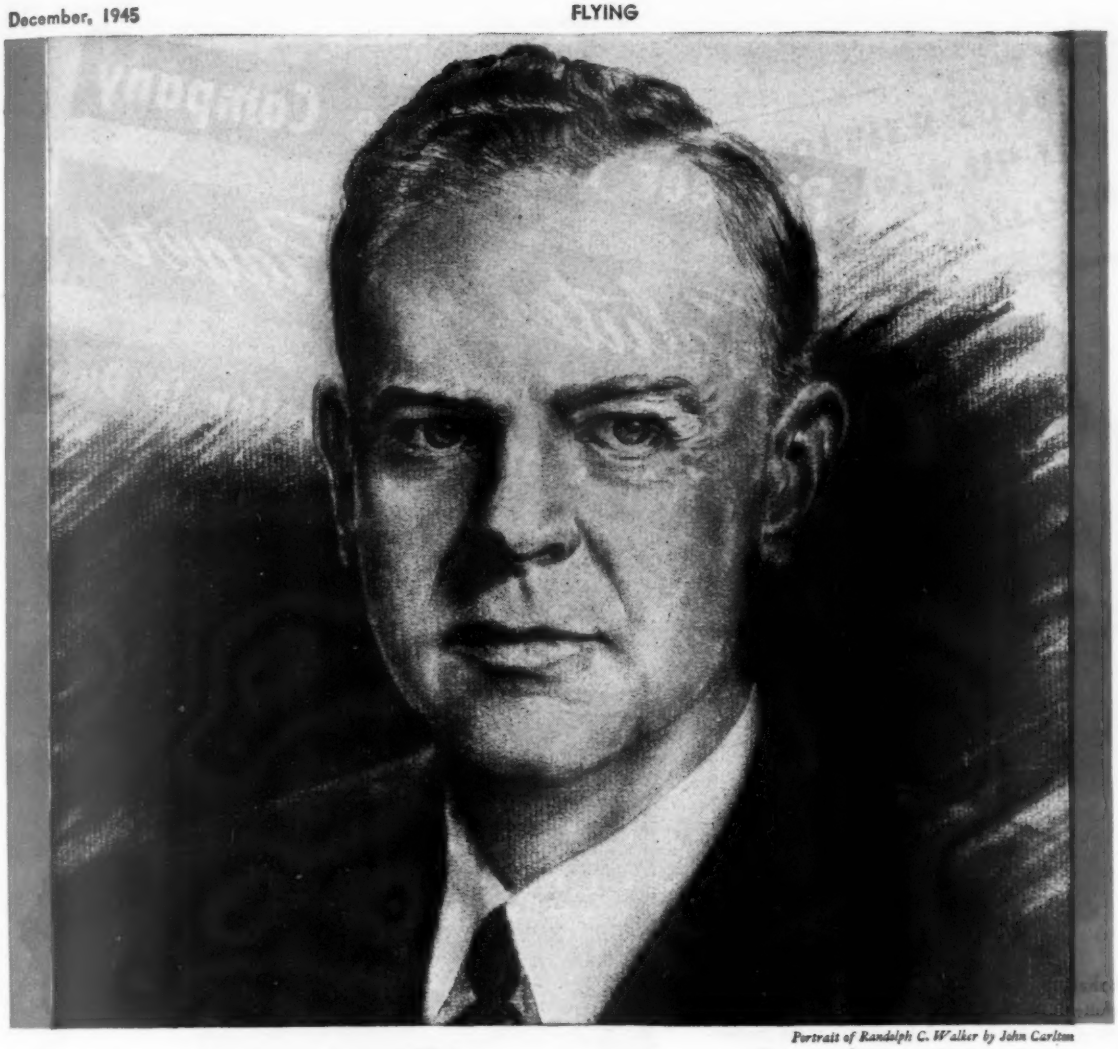
The same old-line opposition that aviation faced in World War I arose again to dog it in World War II. The difference was that aviation was too strong to play a second fiddle and so effective that it overwhelmed those opposing it.

This is not to say that aviation should be ensconced on a throne and everything else be relegated to a minor role. Teamwork won the war and only teamwork can win the peace. But it does mean that aviation should be assayed at its proper value and the less argument about it the better. Our five major questions should be answered promptly and without qualification.

I believe that it is for the greatest good of the country and of the world at large that they be answered as follows:

1. Our air forces, both Army and Navy, should be maintained, regardless of cost, at the highest possible peak so that pilots may be trained in large numbers, equipment will be immediately available in

(*Continued on page 104*)



Portrait of Randolph C. Walker by John Carlton

Engineers of Victory

NOW SERVE MEN AT PEACE

The creative engineering which armed our fighting men for Victory has no less a responsibility in the years of peace ahead. Now that the war is won, we have the job of making this a better world.

AIREON produced huge quantities of communications and radar equipment and other machinery for waging war. Its achievements were equal to its heavy responsibilities, and its workers established an outstanding record of performance.

AIREON enters peacetime production with a notable engineering organization, highly skilled personnel and great confidence in the future. We have developed many products which will contribute to better living, for the manufacture of which all 15 AIREON plants will continue in production.

In order to extend our usefulness we recently established an experimental laboratory in Greenwich. AIREON's creative engineering in radio communications, electronics, musonics and hydraulics will team with production proficiency in contributing devices for future service.

In peace, as in war, AIREON will stand for quality and performance.

Randolph C. Walker
PRESIDENT

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Salutes the Riggers

For Their Continuous Devotion To Duty

IN behalf of the hundreds of people of Pioneer Parachute Company and the thousands of men who have had to 'chute to safety either in the performance of their duty or to save their lives, Pioneer Parachute Company takes this means of publicly saying to the parachute technicians (riggers)... "Thanks for doing an excellent job!" Pioneer Parachutes are designed, engineered and manufactured to be fool-proof and foul-proof — and it is the riggers who keep them that way! Yes, these unsung heroes are as vitally important to the proper servicing of the 'chutes as the aviation mechanic is to the proper servicing of the airplane engine. The riggers, constantly maintaining the standards of Pioneer Parachute Company, are responsible for their continuous, positive performance — the lifeline to every flier. We are proud to salute them!

THIS handsome, walnut plaque is presented to the Riggers who packed the 'chutes used in life saving jumps. The name of the Rigger as well as the names of the Caterpillars are stamped in gold. The plaque is designed to hang in the Rigger's loft as an emblem honoring his craft. Write to Pioneer Parachute Company for further data.

PIONEER PARACHUTES are now available without priorities. NYLON harnesses are now made standard equipment on Models P1B, P3B, ANSS 24, and QAC types at no extra cost.

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FLIGHT TODAY CALLS FOR TRAINING IN THE LINK

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If you would like a taste of flying...to test your reflexes, to see for yourself how a plane acts in that boundary-free element, the air, consider a lesson, or a course, in the LINK TRAINER.

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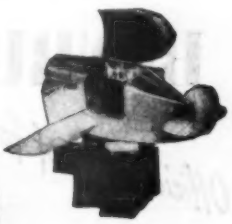

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Official watch of famous Airlines

(*Continued from page* 100)

large numbers in case of a national crisis, and scientific advancement in the field may go forward unhampered by monetary considerations.

2. The AAF and the Naval air arm, not to mention all other national defense groups, should neither be separate units nor controlling factors in our defense plans. All should be combined in a single national defense unit, making teamwork in our military and naval activities an organizational reality as well as a personnel goal. Specifically, the military and naval affairs committees in the Congress should be abolished immediately and a single committee on national defense in each house should replace them. Similar consolidation toward streamlining should be effected in the Army, Navy and the Cabinet.

3. In considering the control of the airplane in its relationship to the atomic bomb, it should be remembered that the bomb would be of dubious military value without the airplane. Without control of the air—which we *must* maintain—control of the atomic bomb would be comparatively useless. At the same time, let us not assume that the bomb is the be-all and the end-all of military offensive. The bitter fact is that if we launch a future war on the atomic bomb level we will be forced to sink to biological, chemical and bacteriological warfare and to face the possible destruction of modern civilization. We must at all cost, therefore, lay immediate and air-tight plans for channeling aviation and atomic energy into peacetime activities and design all our planning away from war. So doing, we may look forward to a civilization fostering life more pleasant than ever before in the history of man. The alternative is death.

4. What international regulations are going to be laid down concerning freedom of the air? This may turn out to be the most important question before the world in establishing and maintaining the peace. The airplane can, given the opportunity, contribute as much to lasting peace as it contributed to winning the war. But its contribution will be nil if we hamper it with dog-in-the-manger nationalistic taboos. Of primary importance to world trade and world peace are a set of free-air cities or free-air islands which permit entrance and exit of planes of all nations without trade or immigration restrictions. Air over the poles and over each of the former Axis powers should also be free, as well as over the Rhine and the Danube and over all mandated territories. Freedom of the air must be more than a phrase, it must be a slogan, the basis for a world program.

5. Domestically, every possible measure should be taken toward full-throttle aircraft production and the employment that such production implies. We must do this or face a depression more severe than any in our history. To cut aviation production back to its pre-war level is to court domestic economic disaster. Nor is the problem economic only. If such a cutback is enforced, it means that some 2,000,000 of America's finest youth trained to perfection in their specialities

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Sleek, graceful, swift as an arrow in flight, yet rugged as our toughest "fighters," the new Skycraft will be more dazzling in appearance, more "ship" than you would ever dream possible in your personal plane. Powerful but light as a feather to control, its refinement and big plane features assure the maximum of safety . an enjoyable peace of mind in flight So, plan your Skycraft order now!

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Any port in a storm ... but there are no ports

More than one sailor has said, "It's a helluva place to fight a war!"

That's a miracle of understatement when you know the Pacific as well as the U. S. Navy knows it.

They know how many thousands of miles you have to go before you reach the fighting fronts.

They know there's almost continual rain and bad weather to hamper operations after you get there.

And they know there are no good ports!

Think of the thousands of ships, and the millions of tons of supplies it takes to keep our fighting forces moving toward Japan.

Imagine, if you can, the problem of handling those ships and supplies with no port facilities.

There are no giant cargo cranes...no miles of docks and warehouses...nothing but beaches, and human backs, and a refusal to call any job impossible.

Remember, too:

It takes 3 ships to do the supply job in the Pacific that 1 ship can do in the Atlantic.

It takes 6 to 11 tons of supplies to put a man on the Pacific battleline, and another ton per month to keep him supplied.

It takes a supply vessel, under ideal conditions, half a year to make one round trip.

Add up those facts, multiply by the number of sailors, soldiers, and marines for whom the Navy is responsible.

Maybe you'll begin to realize what "no ports" can mean in the rough, tough waters of the Pacific.

Maybe you'll see that we have *two* reasons to be proud of the U. S. Navy. *First*, the way they've sunk the enemy's ships.

Second, the way they sail *your* ships ... taking the worst the Pacific can hand them... but keeping the supply lines open ...keeping the attack *on schedule!*

SPERRY GYROSCOPE COMPANY, INC. GREAT NECK, N. Y.

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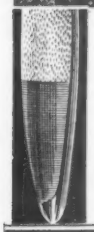

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as *airmen,* will have their talents and their trained skills thrown on the junk heap. These talents are as valuable—indeed, they should be of more value—to our society in peace than in war. They should be neither junked nor squandered. They should be used at all—or any—cost. To jettison them at this time would be as stupid as it would have been to junk the railroads and railroaders after the Civil War. That talent should be used to the full to develop aircraft that will rival the automobile for utility, will make life in our civilization more livable and pleasant, and keep us at all times equipped with facilities and manpower to meet any challenge from other powers that the future may bring forth.

Aviation history will record 1945 as the year when the AAF smashed the *Luftwaffe* and, carrying its deadly atomic bomb, blasted the last Fascist stronghold and brought imperial Japan to its knees. It would be tragic indeed if world history does not also record that, as the year came to a close, we who now control the air failed to make it a highway to permanent peace and sustained world prosperity. END

Sky Spies

(*Continued from page* 42)

stereo pair) were taken, the underground factory was apparently already in production. Although the landing strip was still being widened, two planes could be made out at the top of the cog railway incline. Those black spots at the center right looked like bomb craters. But under the stereoscope they showed up quite flat, a belated as well as an unsuccessful attempt at painted camouflage.

On the basis of the pictures they had, P.I.'s prepared a sketch of the completed installation. The tunnel entrances to the heart of the mountain, and the concrete sheds in which complete planes were assembled look very tiny, but they had to be drawn in proportion to the 3,405-foot-long air strip which crowned the mountaintop. In contrast to this excessive length, the strip was only 100 feet wide—evidently prepared for jet planes only. The finishing touches were just being added to it when VE-day came. Had the war in Europe continued, the narrow gauge railways linking the parts of the unit and the strip itself might have become bombing targets, though it would have taken the 12,000-pound "tall boy" or the 22,000-pound "Grand Slam" to have made a dent on the strip. Even with such a bombardment, P.I.'s guessed that the strip could be put back into use within 24 hours.

During his recent questioning ex-Reichsmarschal Goering had this to say: "Jet planes would have won the war for us if we had had four or five months' more time. Our underground installations were all ready. The factory at Grosseutersdorf had a capacity of 1,000 to 1,200 jet airplanes a month. Now with 5,000 to 6,000 jets, the outcome would have been quite different."

Our men never got a good look at the inside of the factory itself. When Allied troops arrived to take over, the Germans

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Never before in the history of flying have so many American men and women been trained to build, fly and maintain aircraft. Even discounting those who will move to other occupations during the reconversion period, we have manpower to remain secure in the air, both from a military and a commercial standpoint.

However, other nations also have great air fleets and trained personnel. The question of who will carry the world's air commerce is likely to be the subject of international bargaining for many years to come. The nation which consistently produces planes that can be operated at a lower cost will have an "edge" in such bargaining.

In developing post-war commercial aircraft, American manufacturers will enjoy one important advantage over foreign competition. The United States today can produce more high-octane gasoline than any other nation. We have the crude oil, the refining capacity, and facilities for producing large quantities of Ethyl antiknock fluid. Commercial quantities of better-than-100-octane gasoline could readily be produced.

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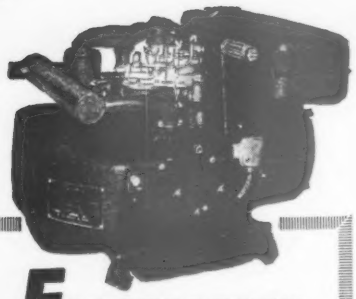

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fired the plant. It was five days before the blaze was under control. But they were able to examine the assembly sheds, the tunnel entrances, and the strip itself. Ground photos revealed how accurate P.I. reports had been.

The Germans were the only ones to complete such mountaintop airstrips, although the Japs tried it several times. P.I.'s found that by figuring out how deep the excavations were on the top, they could guess just how much earth was going to be available as fill to level off the sides. With that clue they could tell both the size of the strip and the kind of plane it was planned for. Measurements must, of course, be computed in relation to some known object such as a ship, railroad car, or tank. If there is nothing in the picture whose measurements are known to the observer, the figuring must be done on the basis of altitude, flying speed, time of day and a complicated table of logarithms which defies explanation in anything short of a book.

Quite early in the war the Japs started hacking out such a landing strip on Attu. P.I.'s sent in several detailed reports on it, but brass hats were reluctant to believe the Japs had any time in between bombardments for such frills as constructive work. Army engineers who surveyed the island after it was taken found the Jap airfield just where the P.I.'s said it would be, and all measurements, even drainage ditches, were within inches of what P.I.'s had reported.

Photo interpretation in this highly developed state is definitely a war baby. Until 1941 we had no military photo interpreters (Sky Spies). The first Army textbooks used to train our P.I.'s presented British photo-intelligence methods developed since 1939.

Both the Army and Navy were choosey about recruits—only engineers, architects, geologists and geographers were accepted. In addition to a general course, such recruits were given specialized training—one might be trained to analyze pictures for communications, another for airfields, another for anti-aircraft emplacements or for radar equipment and still another for bomb-damage assessment.

Still others specialized in urban areas. Our knowledge of Japanese cities was based almost entirely on the work of P.I.'s who counted and analyzed the roofs of each area, determining the population of a town as well as the location of its factories, rail centers, public utilities, and storage facilities.

Just how specialized this task was is evidenced in the fact that even familiar objects in an aerial photo must be pointed out for the inexperienced observer. But experts can recognize a ship at a glance which may show up in a picture the size of this exclamation point! It would be almost impossible for you to see the dot on a picture taken at 20,000 feet which was a six-foot antitank gun pit. The P.I. can even tell you the caliber of the gun.

The pictures which P.I.'s must study

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range all the way from very low level "dicing" pictures—so-called because the pilots threw dice to decide who should fly the mission—to those taken at 35,000 feet or more.

Basic tool of all photo interpretation is the stereoscope, a gadget that works somewhat like the old-fashioned viewing machine at the Penny Arcade. Not only does it magnify, but it makes the pictures appear in three measurable dimensions. To use it the interpreter must have a pair of pictures taken of the same spot, but from slightly different angles so that they overlap about 60 per cent. (Most reconnaissance cameras are so timed that every time the shutter clicks, the picture shows 60 per cent of what appeared in the preceding picture.) The stereoscope is an extension of normal vision. If you hold a piece of paper over one eye and then shift it rapidly to cover the other eye, you will notice that the image shifts to one side, although you see with one eye almost all of what you saw with the other. Open both eyes and the two images merge. In photo interpretation, any succeeding pair of pictures comprise the left and right eye images. With the stereoscope they come together, permitting depth perception.

Though a P.I.'s kit contains a number of items, such as compass, slide rule, engineers metric scale, T-square, ink, pens, crayons and triangle, the stereoscope, ruler and lamp are the real essentials. With those three the P.I. can make a pretty complete analysis of any reconnaissance picture.

When film is unloaded and developed after a photographic mission, the prints are given their "second phase interpretation." They are carefully gone over and compared with earlier shots of the same area. It is this study of "comparative cover" which so often gives away the enemy's secrets.

Occasionally the P.I. runs into a real puzzler. The slab tombs which dotted the Okinawa terrain were one thing that wasn't really figured out until ground troops reached them. Toward the end of the war every airfield in Japan had on it a rather carefully made dummy B-29—so far, no one has figured out a good reason for it. One baffler over in Germany was the Taben Bridge. The bridge had been so badly damaged in raids that it was no longer usable. The Germans had erected a new steel framework parallel to it, but time after time aerial photos showed nothing further being done. Finally a photographic mission was made at night. A magnesium bomb with a light intensity of 800 million candlepower was exploded at 4,500 feet. The night pictures gave the answer. They showed the bridge framework completely floored and with German convoys moving over it toward the front. Comparison with daylight shots revealed where the planking was stored each dawn.

The Army's photo interpretation units were based with the photo squadrons behind the front lines. The Navy has a photo intelligence officer on each carrier. Its photo interpretation units were land-based on those Pacific Islands which served as fueling bases for the fleet. Each time a ship stopped for oil, pictures

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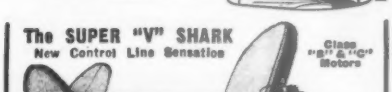

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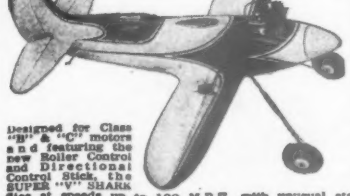

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showing the latest enemy activity were supplied. Toward the end of the war as the fleet closed in on the Japanese, both fuel and photo reports were supplied by tankers. Inevitably, as ships went several days without contact with a base, pictures with map grids superimposed had to be used. New information was radioed with reference to pictures already delivered simply by referring to the position on the grid where an enemy ship had been sighted.

Army and Navy officers came to depend on their photo interpreters for a great many details. The P.I. might be asked about the possibility of finding drinking water on an island to be invaded; he helped select an approach route, an airfield, located enemy defenses, identified objectives for air attacks and advised on proper bomb fusing (either contact or delayed) for each target. They prepared the photo maps which were used by advanced patrols to recognize a spot chosen for dropping food and ammunition. They have a 100 per cent record in choosing safe air strips—often just a sand bar, paddy field, or river edge—for evacuating the wounded. The famous Ledo Road was planned with the help of photo interpreters.

The highly developed science that photo interpretation has become during the war has a multitude of peacetime applications. For modern explorers who set out armed with plane and camera, the world can hold few secrets now. Experienced P.I.'s can tell from pictures the probable existence of oil and ore deposits. Soil erosion and flood control will be better planned. Aerial traffic surveys make precision planning possible. Mapping becomes a matter of minutes or hours, rather than decades. Inevitably photo interpretation will be as useful an instrument of peace as it has been a vital instrument of war.

END

Airport for $400

(*Continued from page 38*)

dust. The runways, one 1,200 feet long (since extended to 2,400 feet) and the other, 1,900 feet in length, looked good enough to CAP Lieut. Walter Howard. He had flown over the spot early in the morning and at four o'clock he returned to make the first landing on the north-south runway.

The two runways were usable that first day, but much work still remained. The following Sunday was used to smooth out and sprinkle the strips—and again everyone helped. Deschutes county and the city of Redmond loaned their big road sprinklers. Following the sprinklers came a tractor dragging a float which had been built by Copper. Redmond Fire Chief John Berning and others. A group of volunteer firemen, headed by Berning, brought Redmond's small pumper to the scene. The Pacific Power and Light Company opened its Cline Falls power plant on the Deschutes river so the truck could deliver water from the stream to the top of the highway grade, 250 feet above. This saved the sprinklers a long haul up

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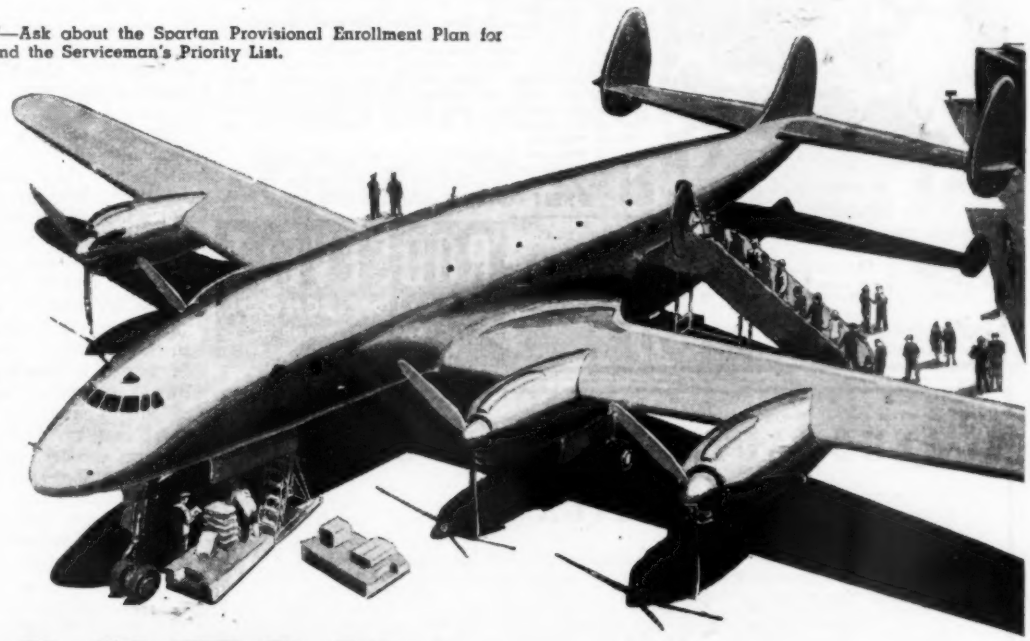

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the grade from a bridge across the river.

On the succeeding Sunday, the air field grader was again used and the 1,200 foot north-south runway was doubled in length. Keith Parkinson, manager of the Deschutes Concrete Products Company, took his bulldozer to the field and donated an entire day improving the parking strip and runways. Then Theodore J. Wells, mayor of Redmond and manager of the Northwest Telephone Company, lowered telephone poles near the highway to minimize any possible landing hazards.

Meanwhile, student flying was on the increase. Redmond's flying club had been organized and had purchased an airplane. Ballantine also bought a trainer. Then, before construction of a hangar proceeded, application was made to CAA for the designation.

About October 1, word came that Washington had granted the designation, and the flying club and Ballantine got busy with plans for their hangar. Materials were obtained wherever they could be found. Part of the old hangar which had stood at Robert Field before it became a military base was obtained. Poles that had been set up during Army maneuvers in Central Oregon in 1943 were bought at low prices, and other used lumber was secured. Total cost of the material for the hangar was about $280.

Lieut. Cooper again came through with his engineering skill and the hangar was laid out and started Oct. 15, a week later. Every member of the club turned out with hammers and saws and with the help of a number of non-flying CAP members, the hangar was built.

The sportsman's clubhouse was put to use as headquarters for the field and telephone facilities were installed. Gayle Bartel donated a wind-tee.

Flying from the two runways was under way daily and students began soloing. Under Ballantine's tutelage, as students tried their wings, they noted that cross-wind landings sometimes were necessary so the sponsors began eyeing the wide expanse to the west as a possible east-west third runway. The land is owned by dairyman Struss. He gave his permission to allow the runway to cross a corner of the grazing land used by his cattle.

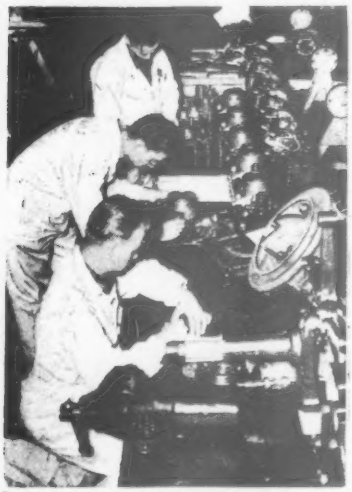
Cooper again surveyed the longer, wider runway of 3,500 feet. This time it was felt preliminary clearing would help, so a contractor was hired to pull up trees and remove brush. The cost was $57.50. Again the air field engineer cooperated and the base's grader was used to level the runway. John Hansen, Terrebonne rancher, furnished his tractor to pull a drag that was kept on the move on a cold, snowy Sunday in January—and the third runway took shape.

Because of the nature of central Oregon's soil, the runways have packed solidly and their surface is in excellent condition. The ground drains readily and pilots aren't troubled with mud or chuckholes. The parking strip has been oiled and visiting planes which stop in Redmond now find facilities for them.

One innovation at the field is the "airplane tee" constructed by Gayle Bartel in the garage at his home. Shaped like the fuselage of a plane, the Bartel invention has an exaggerated tail fin to catch the wind and point the "airplane" upwind in the direction the aircraft should land or take off. The tee is 20 feet long, with a wing spread of 11 feet. Bartel used wood for the framework and covered the surface with canvas, painted a brilliant orange. He developed an unique method for causing the tee to turn as the wind catches it.

First cement was poured and in it was placed a car axle upon which an old car wheel was mounted. The tee was bolted securely to the wheel and was balanced with a box of rocks in the nose. Materials for the tee were donated—even to the labor of welding the car wheel and axle.

Thus has Redmond airport taken form, with a total cash expenditure of less than $400 — simply because a town got together and decided it was time to get ready for its aviation future. While the airport was constructed primarily for use during the Army occupation of the city's Class Four airport, it does offer many advantages for a permanent installation — a field for smaller, privately-owned aircraft, and for the training of students. END



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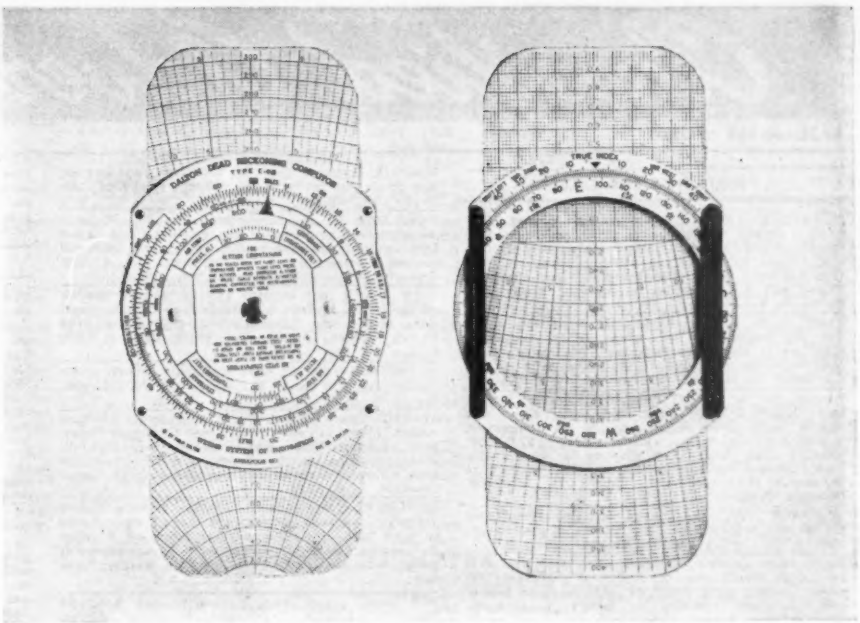

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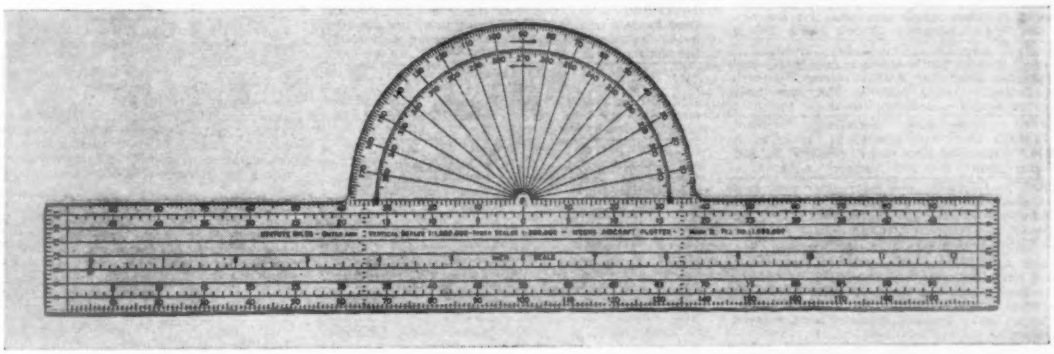

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Clothesline Air Strip

(*Continued from page 64*)

the inventor believes—particularly the northland. Private individuals in the United States could set up their own airport in wooded or extremely rolling territory.

The system's test pilot, Flight Officer Gregory, has his own pet idea as to one of the system's commercial uses:

"Suppose the big airlines had downtown offices in New York, or any large city, for that matter," he mused. "Suppose they sold tickets for some destination, across the ocean or the continent.

"Under the present system they must transport their passengers by automobile to the airport. With the Brodie system, they can take off from the top of the building in which their offices are located. The system could even be attached to the side of the building.

"That way, they'd be using air transportation from ticket to target."

It was back in 1942, while the nation's linotypes daily ran off the bloody box score of the Atlantic, that Brodie, trained in engineering at the University of Minnesota, evolved his highly unusual method of launching and landing lightplanes. Developing the idea was simple compared with the job of selling it.

Finally with $10,000, obtained from the Transportation Corps only after many conferences with Government officials in Washington, Brodie began in April, 1943, to build his first rig at New Orleans. By July he was cajoling transient army pilots to conduct tests. Most of them considered the entire idea dangerous—not to say fantastic.

Son of James S. Brodie, chief engineer of the Inland Waterways Corporation, young Brodie was from the first an extremely water-conscious soldier. His first rig simulated shipboard conditions. Lieut. C. C. B. Wheeler, an Army service pilot, made the first take-off in late August, 1943. The first round trip was made in September 3, 1943, by Major James D. Kemp, a Marauder pilot awating shipment overseas.

By mid-September, the first regularly assigned Brodie system test pilot arrived—Sergeant Gregory, fresh from maneuvers in Louisiana. Anxious for action, Gregory approached the testing with enthusiasm. Not even his first mishap with it dampened the enthusiasm. With Brodie as a passenger, young Gregory had come in for a landing pass. He forgot momentarily the sag in the center of the cable and kept too much altitude. The propeller hit the cable but Gregory managed to dump his L-5 into a safe emergency landing under the rig.

Experimentation in those days was the trial-and-error sort. Brodie's regular assignment was to redesign cargo ships for the transportation corps. He worked out his system during odd hours. Principal mechanical problems were the development of adequate brakes and the reduction of shock during the process of getting the landing trolley accelerated.

Satisfactory braking performance finally was obtained by use of an aluminum reel, two standard hydraulic automobile brake assemblies, and automatic brake delay screw, a tension adjuster and a gauge for determining line tension. The delay screw permitted rotating parts to become accelerated to airplane speed before applying drag.

Brodie designed the trolley in a half-moon, which allows the lower half to pendulum forward before the trolley wheel actually is set in motion. The hook arm swings to a horizontal position and then telescopes outward about two feet upon contact with the landing sling.

Late in 1943 Brodie got the *City of Dalhart*, a 5,800-ton cargo ship with which to experiment on modification of the apparatus for actual sea landings.

In December a series of landings and take-offs were successfully completed on the *City of Dalhart* with an L-5, bringing final vindication of the months of hard work and thought behind what many an official had called too fantastic a project on which to waste money.

Success of the Brodie system was formally proclaimed this year with the presentation of Legion of Merit medals to Brodie and Sergeant Gregory.

Long before these medals signalized success, however, the Army was convinced of the system's practibility. The Field Artillery took great interest in the project and, since the Navy had already won the Battle of the Atlantic, development of the rig was continued along the line of ground forces needs.

In later considerations, however, the system was applied to landing ships for lightplane support of amphibious landing operations. This application has been outstandingly successful. During maneuvers all other planes of the simulated task force were kept aboard by fog, but the two liaison planes attached to an LST were aloft regularly, acting as observation craft.

END

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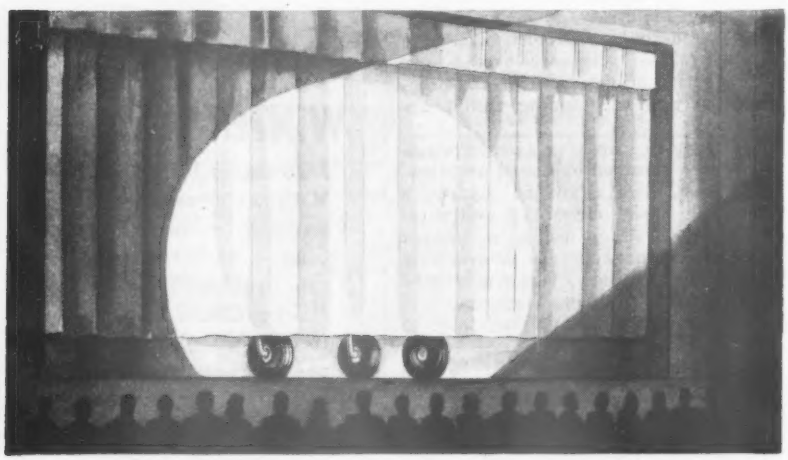
worth waiting for NEWS

No. 11

THE ELEVENTH OF A SERIES OF INFORMATIVE ADVERTISEMENTS ABOUT THE NEW CULVER.
PUBLISHED BY THE CULVER AIRCRAFT CORPORATION, WICHITA 1, KANSAS



YOU WON'T HAVE TO WAIT MUCH LONGER!

The past few years have been years of waiting . . . waiting for new airplanes, new automobiles, nylon stockings, washing machines, radios, electrical appliances, and a thousand other articles which have been unavailable in the war period.

Yes, "waiting" has been a much overworked word . . . and Culver for some months has been talking about the New "V" Model which "will be worth waiting for." And when we said "worth waiting for" we meant just that. For it will not be an old airplane "cleaned up," nor an old design with "under the skin" improvements. We could have "fixed" up the old Culver a little . . . new paint job, larger wheels, and a few other minor changes, and it still would have been the fastest airplane for its given horsepower on the market; but we felt the flying public deserved more than a clean-up of a design eight years old.

But Culver will keep faith with the flying public. And Culver will keep faith with the statement that its new ship will be "worth waiting for"; for the new Culver incorporates all of the concentrated design, engineering, and production experience of the crowded war years. *That new "V" Model Culver is flying at the factory right now;* undergoing every test and flight condition, every quality inspection that Culver engineers have used on three previous designs for the Army and the Navy. So that when that product reaches the hands of the flying public it will be tried and proved, and will measure up to the Culver standards of performance, stability, and quality.

What, in a general way, can you expect in the new "V" Model Culver?

1. Utility . . . the ability of an airplane to get you somewhere cross-country faster, cleaner, safer, more comfortably, and at less cost than by any other mode of transportation.

2. Externally stressed skin low wing monoplane of the same rugged wood construction that has given Culver such a splendid reputation with Army and Navy ground and flying personnel.

3. Electrically retractable tricycle gear with the Mooney power unit which has proved so safe and sure on Army and Navy models.

4. An anti-stall characteristic, thus eliminating spins.

5. Simplified controls, allowing the novice and the beginner to fly safely.

6. Cruising range vastly in excess of the 480 miles of the pre-war Culver.

7. Ample pay-load and baggage capacity.

8. Clean aerodynamic design to Culver's standards, which guarantee maximum performance for a given horsepower.

9. Fuel injection engine eliminating carburetor icing.

10. Full electrically operated flaps.

11. Factory built-in provisions for two-way radio.

12. Individually adjustable air-foam seats.

13. Larger and wider deluxe sound-proofed cabin with a new point of entrance.

14. Many refinements and innovations too numerous to mention.

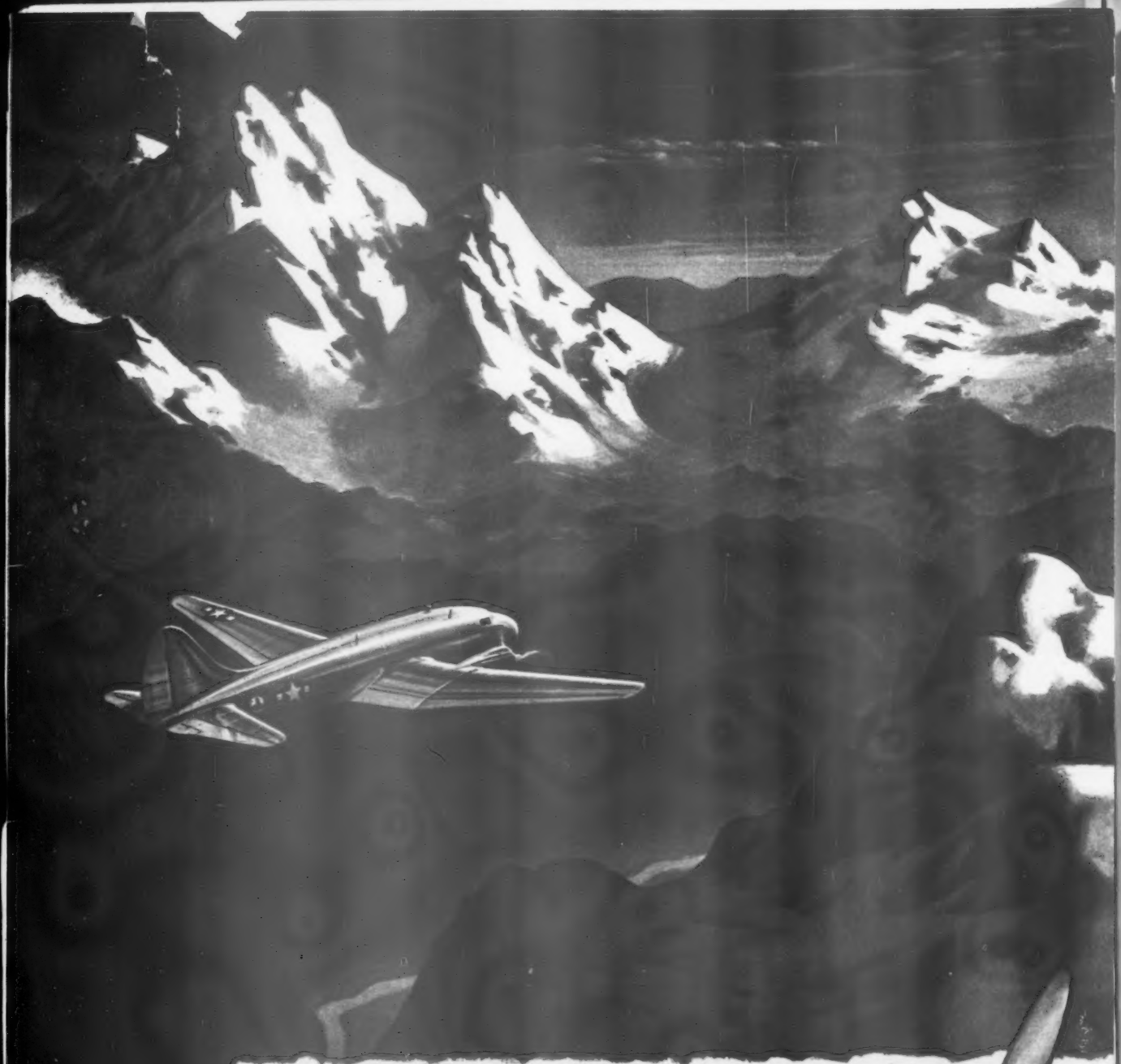
These are some of the general specifications. In the next advertisement Culver will give specific performance data and specifications of what we feel will be the finest quality light airplane ever to be introduced to the flying public.

It will be a short wait until you can buy and fly the new "V" Model Culver; but we still say that new airplane, which is new in every sense of the word, is definitely "worth waiting for."

FOR THE LATEST INFORMATION WRITE CULVER AIRCRAFT CORP., DEPT. FK, WICHITA 1, KANSAS

Printed in U.S.A.

JAP BOMBERS SMASHED THESE VENTURAS AND LIBERATORS AT LEYTE. TRANSPORT LANDING IS A COMMANDO.



Hauling the Load over the HUMP

Air Transport Command operations in the China-Burma-India area have become a symbol of reliability and endurance, both of men and equipment—a reputation built on day-in, day-out, all-weather flying over the world's roughest terrain, often under attack. The performance of Curtiss Propellers on C-46 Commandos along this aerial Burma Road typifies their dependability in air transportation.

Curtiss-Wright Corporation, Propeller Division

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